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NEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

VOLUME XXVIII

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EBRUARY 1943

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NUMBER TWO

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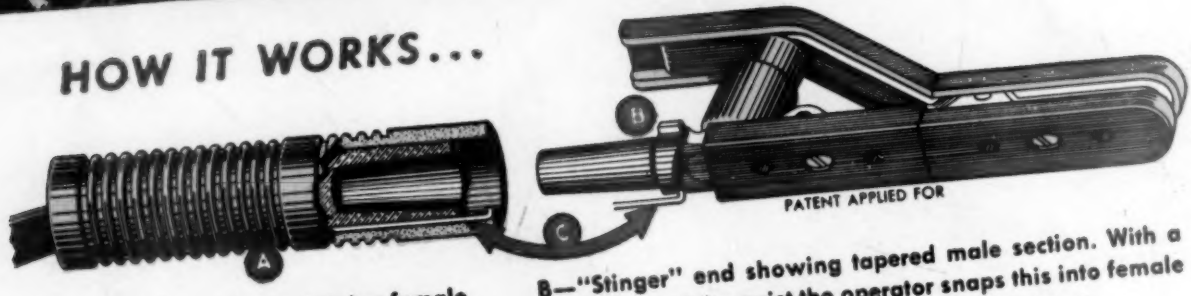

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The Welding Engineer

Vol. XXVIII, No. 2 February, 1943

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Published on the 1st of each month by The Welding Engineer Publishing Co., 506 So. Wabash Ave., Chicago. Telephone Webster 7134.

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Subscription, United States, possessions, and Canada, $3 a year; foreign countries, $4 a year; single copy, 35 cents. Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

FOREIGN REPRESENTATIVES: AUSTRALIA and NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand; BRAZIL—Alpha Jewel, Caixa Postal No. 2411, Rio de Janeiro, Brazil; GREAT BRITAIN—A. D. Baynes, 1 Cambridge Park Court, Twickenham, Middlesex, England; SOUTH AFRICA—J. W. Arnison, 35a Victoria Avenue, Benoni Transvaal, South Africa; U. S. S. R.—Mesdunarodnaja Kniga-Kusneski Most 18, Moscow, U. S. S. R.

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Meco Aviator has GONE TO WAR

The Meco Aviator Welding Torch will no longer be available, for the duration — the vital alloy used in making the one-piece forged handle of the Aviator has been called to *front line* duty.

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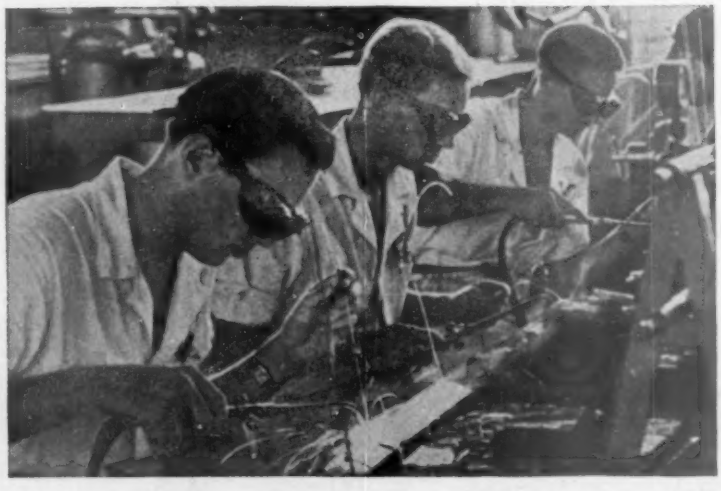

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WELDING AND CUTTING EQUIPMENT

MODERN ENGINEERING CO.

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The Welding Engineer

AMERICA'S PIONEER WELDING JOURNAL

Established 1916

Welding Is on Trial Again

Those who have long been critics of welding and welded construction are again ready to, in the parlance of the weldor, "Throw welding in the jug". The exact criminal charge has not yet been filed, but diehards would lead us to believe that the crime is of such magnitude that welding should not be used again.

Some of the diehards, particularly those in the consulting engineering fields, have until recently opposed welding. The two prevailing opinions as to their reticence to accept welding have been: (1) they are too lazy to investigate the possibilities of welded design or () the use of the welding would result in a reduction of their fees because of the resulting reduction in costs.

The latest attempt of those who would impede progress centers around the 16,500 ton tanker, *Schenectady*, which sank at an outfitting dock in Portland on January 16.

Why would a newly launched 523 ft tanker break in two—let down in such a manner as to tear, not along welded seams, but through thick steel plates from deck to keel? Such was the accident which occurred just a few hours after the *Schenectady* had completed successful trial runs.

One "expert" tells us that it was because of the lack of flexibility —a feature he says to be inherent in welded ships. He said, "This break probably would not have occurred in a riveted ship."

Not having had an opportunity to investigate this mishap, any opinion I might make would class me as an "expert" also. Others have told me, however, that welded ships are flexible—limber, in fact—and that they can take hogging and sagging in a seaway without opening seams, a situation sometimes experienced on riveted ships in heavy seas.

The exact cause of this failure may never be determined. At least, it won't be known until after the present investigation is completed. When the story is finally told, we of the welding industry will feel sad—sad for the diehards who then will have much longer faces.

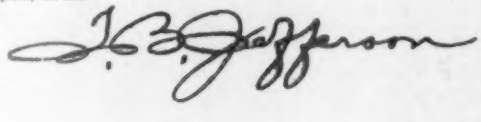
It would be difficult for any jury to convict welding, particularly so in view of the witnesses who can present evidence in favor of the defendant.

First of all, the *Schenectady* is not a tanker of untried design. Dozens of tankers of this design have been built and are now plying the seven seas. None have been broken in two, although some have been shot in two—only to be repaired and returned to sea. Welded ships can take the rigors of the war and strains of the sea as so many of our fighting craft have proved*. Tankers do equally as well as is told in a brief article elsewhere in this issue (see page 46).

Had the welds failed there might be a reason to blame welding, but when plates failed it would possibly be better to look for the source of the trouble elsewhere. One potential trouble source might be in the steel, though this is very unlikely. The most plausible explanation is that the mid-section of the ship was resting on bottom as a result of a rapidly dropping river. Previous experience with ships aground—welded or riveted—has proved that all ships may break apart by rocking on high ground under their mid-portions.

The irony of the situation for the diehards is that welding and cutting have already been called to the aid of this stricken ship. the keel plates have been severed by underwater cutting, and the ship will soon be towed to dry dock where the separated pieces will undoubtedly be welded together again, permitting the *Schenectady* to serve its useful purpose.

*See THE WELDING ENGINEER, April, 1942.



Will Your "FORTRESS" Be Ready On Time?

Think of the months of training and practice this bomber crew put in before they were ready for the real test.

ALTER EGO: And, think of the *years* of effort engineers and shop men put into the development of the "Flying Fortress" . . . all to enable the crew to rule the airways—to navigate in a bee-line to the destination, fight off "competition" all the way, hit the target and get home safely.

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★ PRODUCTION

Welding Weapons for Victory

Many men who learned welding during the depression on the "make work" program at the Pullman-Standard plant are now applying this knowledge to turn out war implements. Using giant positioners, Pullman eliminates vertical and overhead welds, saving hundreds of man-hours in tank manufacture.

By **ROY J. QUINN**

CONSTANTLY broadening its sphere of influence in the war effort, welding is gradually replacing other methods in the fabrication of important ordnance material.

Welded tanks have replaced riveted models.

Welding is making possible amazing records in the nation's shipyards.

Welding is lending impetus to the manufacture of heavy artillery and large field pieces.

Welding is even replacing light riveting in many phases of aircraft construction.

Prewar Beginnings

While the war has been the immediate factor in the present vast expansion of the welding field, yet it cannot be given the full credit. Welding was on its way before the war. Studies of plants in which welding is playing a dominant part today usually reveal prewar plans that were adjusted to war needs after Pearl Harbor.

One of the most striking examples of how prewar welding plans have been put to work to increase the flow of war goods may be found in the arsenals of the Pullman-Standard Car Manufacturing Co. This company, needless to say, builds freight and passenger cars for the nation's railroads. Back in the early 30's, Pullman began studying means of improving railroad rolling stock. Passenger air conditioning was developed in 1929; the lightweight all-welded freight car was born in 1931, and the first streamlined train was delivered from the Pullman-Standard shops in February, 1933.

Welded Freight Car

The lightweight freight car, Fig. 1, plays a particularly important part in our story. In designing it, company engineers also replaced heavy cast steel with shop-made parts fabricated by welding — a change considered radical at the time. The company had in mind a dual purpose: to secure a lighter, functionally streamlined freight car which would save money through lower haulage costs and also to "make work" for its men, many of whom were idle during that depression period because of lack of new car orders.

The application of welding techniques placed on the market a new freight car, which was tested by the Association of American Railroads and given the following endorsement: "The stresses, in proportion to the yield point of the material, were in general lower on the Pullman-Standard car than in the A.A.R. car at practically all speeds of impact."

Welding was to play an even greater part in the production of this type of freight car than was at first planned. When engineers in 1941 began to experience difficulty in getting either cast or rolled steel, lighter weight welded parts (designed earlier in anticipation of such an emergency) began to replace center filler castings, draft lugs and striker plate castings, lending longer life and adding greatly to the company's ability to obtain the materials necessary to build cars.

With this background, there is little cause to wonder that Pullman-Standard was coöperating with the Government in conducting tests on the welding of armor plate over 18 months ago—at a time when American ar-

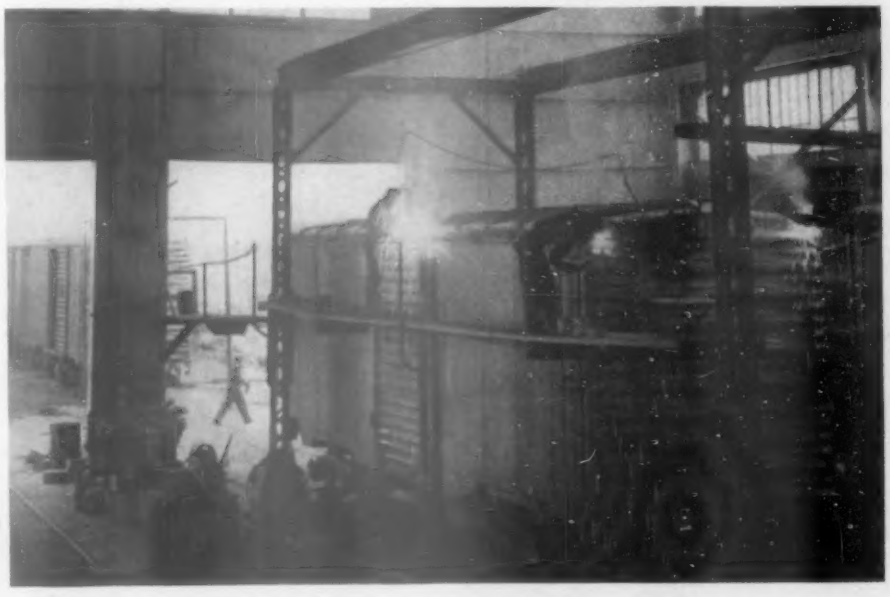


Fig. 1—A lightweight freight car receiving its finishing touches in one of the Pullman-Standard plants. The knowledge gained when company engineers designed for the replacement of heavy cast pieces with lighter welded parts later proved invaluable in war work.

Fig. 2—As an outgrowth of its early experience in welding the lightweight freight car, Pullman-Standard developed these giant positioners or "manipulators," which are able to grasp the hull of a 30-ton tank and turn it end-for-end or upside-down so that all welds can be made from a downhand position. This one development made possible an 800% increase in tank output when Pullman-Standard turned from railroad cars to armament making.

senals generally were turning out nothing but riveted tanks. The Pullman samples passed successfully through the firing tests at the Aberdeen, Md., proving grounds and helped pave the way for the introduction of the all-welded tank, one of the most efficient war weapons ever created by any nation.

30-Ton Positioners

Production of welded tanks at the Pullman plant has been greatly facilitated by the employment of giant positioners which are able to grasp the hull of a 30-ton M-4 tank and turn it end-for-end and upside-down. These mammoth jigs, Fig. 2, are a development of positioning fixtures used by the company in the welding of lightweight freight cars, Figures 3, 4 and 5.

The big positioners, or "manipulators" as they are sometimes called, weigh 14 tons each and are so versatile in their operation that not a single vertical or overhead weld is necessary in the entire complicated task of tank hull fabrication. These welding positioners are held to be one of the leading examples of industrial ingenuity to come out of the war.

The advantages of positioning for downhand welding are well known but will nevertheless bear repetition. First, there is the minimizing of weldor fatigue, in itself a cause of greatly increased output. Next weldors who work exclusively in the downhand or flat position need not be so skilled nor receive such lengthy training as those who are required to make occasional welds in the difficult vertical and overhead positions. Finally, downhand welding permits the use of larger electrodes which are also faster melting because of the greater heat that may be applied. Thus production is speeded up in every possible way.

800% Production Increase

On thick armor plate such as used for tank hulls, positioned welding is of particular importance. By confining its welding to the easy downhand position, Pullman-Standard is saving hundreds of man-hours in tank manufacture. Moreover, comparatively inexperienced weldors are enabled to work on tanks. So important are all these advantages that the development

Figures 3 and 4—Two views of small positioning jigs which were developed back in the early 30's when Pullman-Standard was designing its lightweight freight car.

Fig. 5—The center sill bleacher or "tumble bug" uses air cylinders to turn freight car sills into the various positions required for downhand welding. Welded center fillers and strikers, perfected by Pullman-Standard engineers, lightened and strengthened the entire center sill.

of the 30-ton manipulators is declared to be largely responsible for making possible an 800% increase in tank production at the Pullman-Standard arsenal.

Development of the man-size jigs needed for tank fabrication required three months of intensive work by a staff of company welding experts headed by William Boese, a pioneer who began welding in 1921 at the company's Michigan City, Ind., freight car works. Boese, who welded the first center sill (Fig. 5) in the history of railroading, claims emphatically that "the company's pioneer experience in welding heavy freight car underframes made the speedy process for tanks possible."

The positioner for tank welding consists of two parts: a movable truck and a jig. The jig proper holds the hull plates in position for welding. It is supported by the truck, a heavy steel frame, 15 by 24 ft. The truck is mounted on four railroad car wheels and runs on a broad gauge track. Within the truck frame, the jig is suspended from ball-and-socket type joints and can be readily tilted or rotated to any position. Thus the weld metal is always directly above the joint to be welded.

At the Pullman plant, Boese also points out, welding has eliminated most of the time formerly required for machining and grinding the armor plate in preparation for riveting.

Field Gun Carriages

Another example of the application of the Pullman company's welding knowledge and experience to war work came when a department was opened to make carriages for large field pieces. One of the main sections of the carriage, the cradle, had previously been machined from a solid steel bar. Applying the same techniques which led to the strong, all-welded center sill in the lightweight freight car, Pullman-Standard designed a welded cradle. Though fully as efficient as the solid piece, the new job was considerably lighter in weight and required less steel.

Shipbuilding, Too

Just recently the company accepted still another, and perhaps even more spectacular, responsibility in supplying our country's war needs. The same plant which once produced the streamlined train is now building sleek sub-chasers for the Navy, Fig. 6. These ships are of practically all-welded construction. All of the company's previous welding experience and ingenuity have been utilized in the shipbuilding department, which has straight-line production methods in effect that put shipbuilding on a mass production basis. Supplementing the efforts of the hundreds of men engaged in ship welding are women weldors (Fig. 7) who have just recently graduated from the company's training school.

Fig. 7—Mrs. Katherine Greathouse, left, and Mrs. Phillip Powell were recently accepted as weldors in the Pullman-Standard shipbuilding division. The women passed company tests after taking welding training in a technical high school.

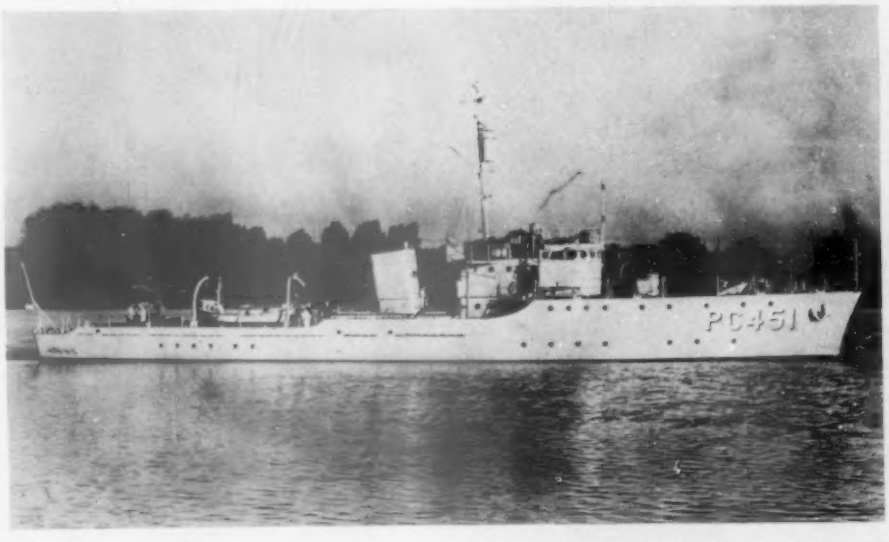


Fig. 6—Manufacture of sleek sub-chasers like these is the latest responsibility assumed by Pullman-Standard. The company is applying welding techniques to a great deal of the fabrication.

Official U. S. Navy Photograph

Correcting Distortion in Large S

Confronted by a rapidly expanding program, shipbuilders are striving to prevent distortion through improved control over welding and to devise effective and economical procedures for removing whatever distortion does occur.

Fig. 3—Improvised positioner, made from scrap material, to permit downhand welding of pipe tunnel frames. These frames can be straightened cold after welding.

Without the use of arc welding and oxy-acetylene processes, the modern subassembly method, which makes possible the amazing speed at which ships are being produced today, would be virtually impossible. Unfortunately, there is a saboteur, lurking in both arc welding and flame-cutting, whose name is Old Man Distortion. He works to reduce the strength of ship hulls and to cause more or less serious delays in fitting-up operations. His ways are insidious, and the problem of counteracting them one of extreme difficulty.

In a previous article, Mr. Grover discussed the principal methods used by shipbuilders and steel fabricating plants for holding distortion to a minimum. He now takes up the correction of distortion through such means as cold straightening, hot straightening and flame-straightening. Taken together, these two articles provide a thorough coverage of this timely and vitally important subject.*

THE designer of ships and other large fabricated structures can do much to help eliminate distortion and thus avoid the necessity for straightening. His problems, though, are by no means easy ones. For example, designers have been advised always to balance all welding about a neutral axis, such as the *y-y* axis of the hatch girder shown in Fig. 1. Apparently the correct rule is not so simple. The welds *a* and *b* that join the face plate to the web cause a lateral bowing, *e*, which might be expected to increase when further welds, *c* and *d*, are made on the same side of the *y-y* axis to attach the chafing bar. It has been found, however, that the effect of these welds is to cause a decrease in *e*. Perhaps the heating effect of the new welds is just enough to relieve some residual stress in the welds *a* and *b*.

Design Considerations

One of the most important precautions for the designer to take is to specify no more welding and no larger welds than are necessary for strength and for elastic stability, which are usually the only criterions for proportioning the welds. Welding specifications and rules often work out in practice so that intermittent welding involves less deposited metal than the minimum permissible size of continuous weld for the thickness of metal involved. Distortion increases with a comparatively small addition of deposited weld metal, the increase being more than one would expect.

The insidious waste of time, labor and electrodes involved through the making of oversize welds too often passes unnoticed in shipyards and fabricating shops, even while much attention is being given to avoiding the lesser waste resulting from the rejection of long stub ends of electrodes. Welding operators should be provided with weld-size gauges and should be required to use them.

In many cases where elastic stability rather than strength is the controlling consideration, matched or chain fillet welds can be changed to staggered welds, omitting each alternate opposite increment and thereby cutting the welding in half. There are relatively few places, it seems, where it is necessary to develop the full strength of the material by means of fillet welds.

Certain details sometimes used for bulkhead stiffeners are not well chosen: for example, angles or flanged plates with both toes welded to the plating and the heel outstanding—even flat bars and small solid half-rounds welded flat against the plating. Because of their small moment of inertia, these details are almost worthless as stiffeners to resist either loads or welding distortion.

It is well known that unsymmetrical sections like channels or angles tend to twist when they bend because of unbalanced distribution of internal

*"Preventing Distortion in Large Structures," page 40, THE WELDING ENGINEER, January, 1943.

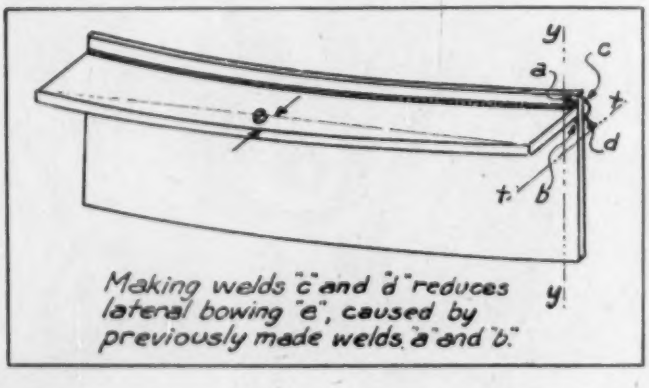


Fig. 1—This drawing of a hatch girder indicates that distortion problems are not always simple ones. Instead of increasing lateral bowing, as might be expected, the welds at "c" and "d" reduced the bowing caused by the earlier welds.

Structures

By LA MOTTE GROVER
Structural Welding Engineer,
Air Reduction Sales Co.

Welding and flame-cutting never stop in a shipyard. These three Liberty Ships were ready for launching on the night before Maritime Day. The subassembly area is in the foreground.

stresses.† It is to be hoped that eventually steel mills will roll symmetrical sections which are more suitable for welding in bridges, buildings and other structures as well as in ships. In the meantime, however, it is often expedient to fabricate such symmetrical sections as tees by splitting rolled beams.

Corrugated Plating

The use of heavy corrugated bulkheads for tanker construction, such as shown in Fig. 2, suggests that lighter weight deformed plating might be used for machinery casings and other structural bulkheads to resist distortion. This principle has been applied in making truck and bus bodies and railway cars.

†See Fig. 6, *a* and *b*, page 42, THE WELDING ENGINEER, January, 1943.

A structural arrangement that affords stiffening in two directions, involving both longitudinals and transverses, resists welding distortion much better than framing in only one direction. It also provides better resistance to horizontal axial forces in the plane of the plating of decks and bulkheads. This is often as important a criterion of design as resistance to normal loads.

It is nearly always advisable to use the widest plates obtainable for bulkheads as well as for decks. The reduction of welding thus accomplished saves time and will save more cost than the extra charge for the wider plates. With the 96 in. maximum width prevailing under war conditions, it is necessary either to run superstructure bulkhead and house-side plating vertically, with frequent seams, or else to use a coaming plate to make up the required height. In both cases, the extra welding makes distortion control more difficult.

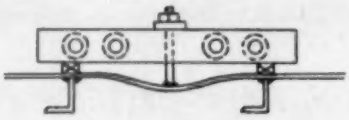
The designer can also facilitate distortion control by arranging details as well as possible to balance the heating and distortional effects of the welding and by following such other well established principles of good welded design as making the welds easily accessible.

Design has often been blamed for more than its share of the trouble. For example, when the top edge of a bulkhead is set too high and deck beams on both sides of the bulkhead are forced down to make their end connections, it appears that the deck has sagged. Especially is this so when there happens to be a deck house side directly above one of the nearby beams. However, there are places where deflection as well as strength of beams must be considered in design.

Fig. 2—Corrugated bulkheads, ⅜ to ⅝ in. thick, being trimmed for tankers by means of a specially improvised tilting torch trailer. The cutting speed varies from 14 in. per min downgrade to 19 in. per min upgrade.

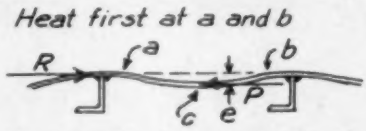
Cold and Hot Straightening

If welded parts are small enough to be handled in straightening rolls or presses, it is often cheaper to straighten them cold after welding than it is to jig and clamp in order



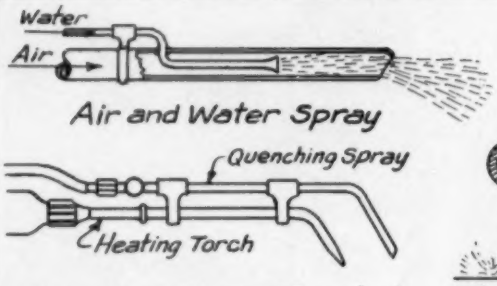
Strongback for isolated sharp buckle. For extensive buckled surface, use longer strongbacks extending over several panels.

FIG. 4

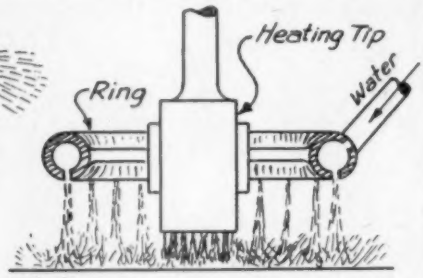


Heat applied at center of buckle, c, will not cause upsetting, because of eccentricity, e, between expansion force, P, and resisting force, R; and because c is too far from stiffener to be restrained from further buckling.

FIG. 5



Quenching Spray Mounted on Oxyacetylene Torch.



Water-Quench Ring and Style 110 Multi-Flame Tip.

FIG. 6

to prevent distortion. Pipe tunnel frames like the one shown in Fig. 3 can be cold straightened in a press, or on a roll used as a press, more quickly than by flame-straightening or hot peening. Sharply kinked edges of plating can be cold straightened easily with a rail bender.

The term "hot straightening" has been chosen to refer to straightening accomplished largely by the addition of force or a strain, furnished by jacks or strongbacks (Fig. 4) or with the help of a maul and flatter. Distinguished from this is "flame-straightening" in which the inherent stiffness of the plating or assembly alone is relied upon to furnish the reaction, R (Fig. 5), which produces the necessary upsetting during the heating to remove slack metal and cause buckles to disappear. Care must be exercised to avoid reckless overshrinking of decks or bulkheads because shrinkage can accumulate with objectionable results, in the same manner as cumulative weld shrinkage.

Flame-Straightening Procedures

One of the most common mistakes made in flame-straightening is to use too high a temperature and too large spots or too wide lines. In what has seemed the most effective procedure seen by the author, the metal is heated only until it barely shows color in the dark. The heat should be applied first at the edges of the buckles, working in toward the middle if any further heats are necessary. Heat applied at the center of a buckle, *c* in Fig. 5, will not cause much upsetting because of the eccentricity, *e*, and because *c* is too far from a stiffener or beam. The buckle will just spring out more, at least temporarily.

A somewhat higher temperature and a different location of heats can be used in hot straightening with the aid of jacks, mauls and flatters, etc. When a strain is put on a buckle prior to heating, the plate should not be sprung too near to a fair condition, or it will warp out in the opposite direction upon the application of heat. For severe buckling, especially in light plating, or for the removal of sharp bends or knuckles, hot straightening must be used, at least in conjunction with the flame-straightening. Without added force, it is difficult to flame-straighten bulkheads or decks before they are erected and have surrounding restraint.

Methods of Quenching

An oxy-acetylene torch is universally used to provide the highly concentrated heat necessary for flame-straightening. With this torch, a water spray is frequently used immediately after the heating to accelerate and increase the amount of shrinkage. Often the quenching spray is mounted upon the torch so that it will follow two or three inches behind the heating tip. Sometimes a ring spray is used, surrounding the heating tip and thus making the heat more concentrated. Both methods are shown in Fig. 6.

Fig. 7 shows the use of a separate torch and quenching spray, permitting the quenching of one spot while the next one is being heated. This seems most efficient because there is no waste of gases from an idle flame and no time is lost in shutting off the torch during quenching and relighting it afterwards.

Sequences, Equipment

Ordinarily, not enough attention is given to the general sequence of flame-straightening operations in various parts of a ship. It is as illogical to neglect this as to pay no attention to the general sequence of welding. Admittedly, it is more difficult to hold to an exact sequence in flame-straightening because the fairing must be coördinated with outfitting operations. Nevertheless, sequence planning should be undertaken.

The sizes and styles of heating tips now in service vary quite widely. The most effective practice seems to be the use of the No. 6 or No. 8 single-flame tips or small multi-flame tips for flame-straightening light plating. No. 10 single-flame tips or larger multi-flame tips such as a descaling tip are used for fairing plating weighing 15 psf or more. A general purpose torch is more convenient than a heavy-duty torch, unless the torch can be mounted on a pair of small wheels, as is done in fairing a deck.

Spot Heats

A controversial question is whether to use spot heats, such as those shown

Fig. 7—Fairing a superstructure deck by spot heating and quenching. One spot is quenched while the next one is being heated.

in Fig. 8, or continuous line heats. Spot heats are more common for fairing light plating. Heating is first done either directly opposte the stiffener or deck beam welds or sometimes along a line about two or three inches away from the stiffener or beam. It seems likely that such heat has a stress relieving effect which acts to decrease the shrinkage that occurred during welding. If the heating is overdone, it can cause deck beams to sag or bulkhead stiffeners to bow. Beams or stiffeners which have bowed much during welding should be faired by heating their heels and jacking or shoring before fairing of the plating is started.

After heats have been made near all the beams or stiffeners throughout quite an area of the deck or bulkhead being faired, distortion may still remain. It is then necessary to add further heats, always working in from the edges of the buckles toward their centers. Sometimes a few cross lines of heats are advisable in order to keep the buckles from coming back at a later time.

Fig. 9 shows an entire area covered with heats. This is seldom necessary if excessive temperatures and too large spots are avoided. Distortion so bad as to require such drastic treatment usually indicates that jacks or strongbacks or a maul and flatter should have been used.

No Simple Answer

There is no royal road to distortion control. The problem is not a simple one; it requires careful supervision and vigilance all along the line of production operations. Working forces should be furnished with clear written instructions and well illustrated, completely standardized procedures.

Confronted with a rapidly expanded production program, shipbuilders have found it difficult to devote as much attention to some details as they normally would. However, they are striving earnestly to conserve strategic materials, to reduce manhours of labor and to eliminate waste.

Development of the arc welding and oxy-acetylene processes in shipbuilding has made possible the modern subassembly method through which Ships for Victory are now being produced at a hitherto undreamed of speed. Such development is due in no small measure to the progressive and farsighted policy of the American Bureau of Shipping, which has been encouraging the use of the electric arc and the oxy-acetylene torch throughout the last fifteen years.

American shipbuilders and the U. S. Maritime Commission must be accorded the highest praise, not only for the production rates they have achieved but also for the quality of the ships leaving the ways. That quality is well attested to by the excellent performance of our new ships in delivering war supplies, materials and personnel to all parts of the world.

* * *

The writer wishes to acknowledge the assistance given by shipyard workers throughout the country in gathering the information presented in this and a previous article. He also wishes to thank the Ingalls Shipbuilding Corp., the California Shipbuilding Corp., the West Coast Kaiser Shipyards and the Maritime Commission for help given in providing the photographs.

WARNING!

DON'T TALK SHOP outside. The only person who cares to hear about your job is the enemy. If the man next door is a turret weldor and you happen to meet him down at Joe's, why not talk baseball? Hitler doesn't care who will cop that championship; he's playing in another league.

Hitler is an easy man to reach by way of the grapevine of rumor and loose talking these days. And when his agents overhear you talking shop, you may be talking a language that Adolf understands. So don't let his stool-pigeons tap in on your conversation!

Fig. 8—Effects of spot heating and quenching on a deckhouse bulkhead. The spots are located opposite the welds joining the stiffener to the plating.

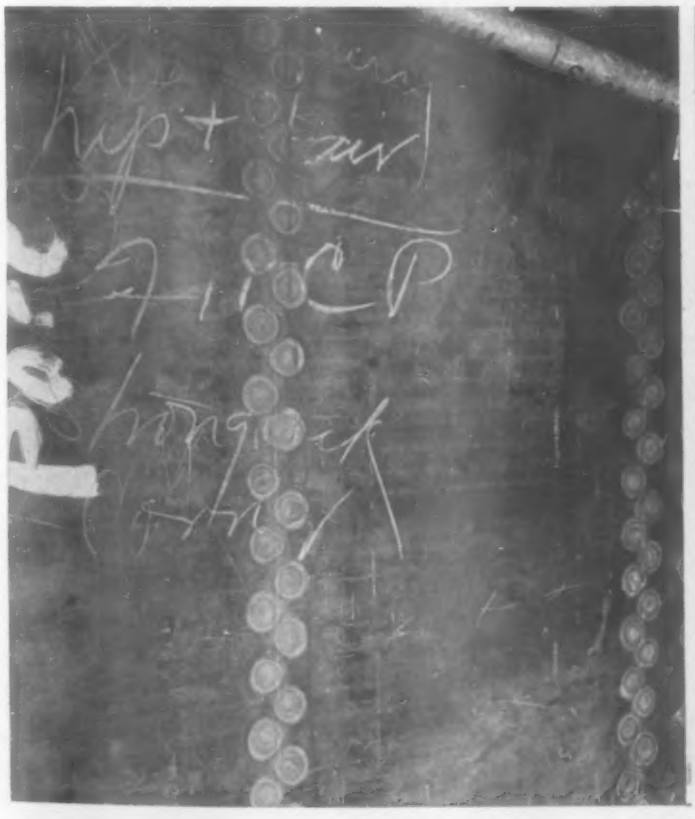
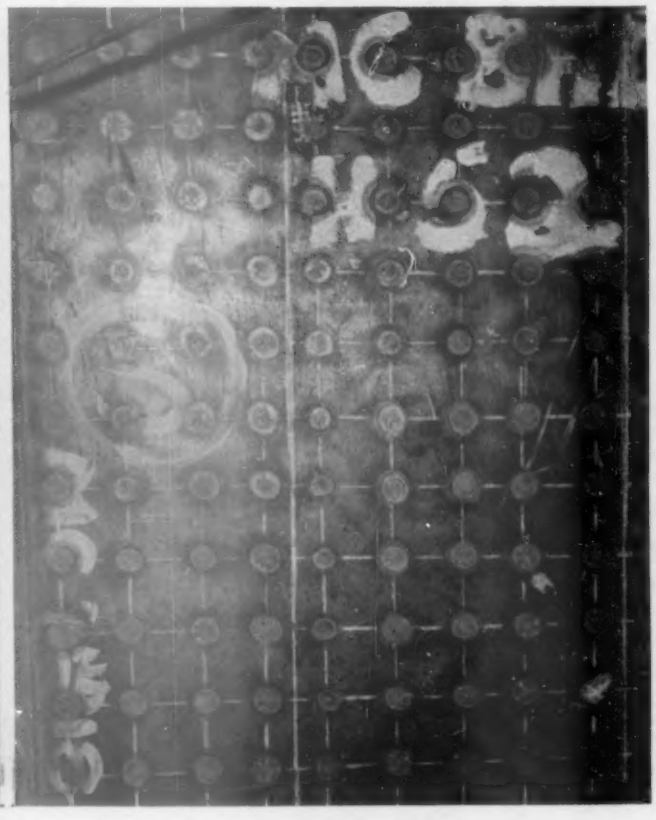


Fig. 9—It is seldom necessary to cover an area completely with spot heats in this manner if excess temperatures and too much heat are avoided.



★ MAINTENANCE

Field Maintenance Welding

★ **Part One—Now that replacement parts are unavailable, field maintenance servicemen are being forced to employ welding as a means of keeping vitally needed equipment in operation. For those servicemen who are relatively unfamiliar with welding, Mr. Brooking has written a new three-part series of articles suggesting a field set-up and pointing out possible pitfalls and their avoidance.**

THE USE of arc welding for maintaining, repairing and servicing machines is more important now than ever before. There are several reasons for this:

First, a great many new machines are made by welding their parts together; hence the material of which the parts are made must of necessity be weldable. This trend alone has considerably enlarged the use of arc welding for equipment maintenance.

Second, better welders and a wider variety of electrodes allow the experienced welding serviceman to do a wider variety of welding jobs on all types of equipment, whether originally welded or not.

Also Portable Equipment

Third, portable welding machines have been developed because of the large amount of equipment which can be welded in the field. Such a portable welding unit is shown in Fig. 1. The initial purchase price and maintenance cost of such equipment has become low enough so that it can be bought and operated at a profit.

Fourth, public confidence in the arc welding process as a means for repair and service has been fostered by a lengthy record of successful accomplishments.

Fifth, the speed and comparatively low cost of arc welded repairs is continually winning more and more converts to welding maintenance procedures.

Sixth, the fact that a piece of equipment can be almost completely taken apart and rewelded for alterations or additions in the field, under almost any conditions, has made it worthwhile to many contractors to have a trained welding serviceman and the welding equipment which he needs. There is almost no part on any welded piece of equipment which cannot be cut out and replaced in the field, provided the part itself can be fabricated without the use of special machine shop tools.

Seventh, the fact that partially worn pieces can be rebuilt by deposits of weld metal, or can have pieces welded onto them in order to restore their original size and usefulness, renders arc welding an extremely important method of conserving the expensive batter-and-impact-resistance steels used for such parts as rollers, tracks, ground plates, etc. The importance of this use of arc welding has been considerably enhanced by the war drive to conserve strategic war materials.

The equipment needed for field welding must include: (1) a D-C welder mounted on a portable truck, (2) electrodes, (3) personal equipment and tools, (4) an oxy-acetylene flame-cutting and heating outfit.

Welding Machines

An all-around useful portable D-C welder should have a capacity of at least 200 amp and a good power driving mechanism to operate it up to capacity. It should also have easy current adjustments and an adjustment permitting, with reasonable convenience, change from straight to reverse polarity. Such a unit has sufficient capacity so that an operator can use $\frac{3}{16}$ in. electrodes all day long and $\frac{7}{32}$ in. electrodes for short periods without damaging the machine.

A D-C welder allows the operator to use the greatest variety of electrodes and to get the largest variety of adjustments to fit the special jobs

Fig. 1—Such portable welding units as this have been developed to meet the repair and maintenance requirements of the large quantities of welded machinery in modern industries.

f Heavy Construction Equipment

By **WALTER J. BROOKING**

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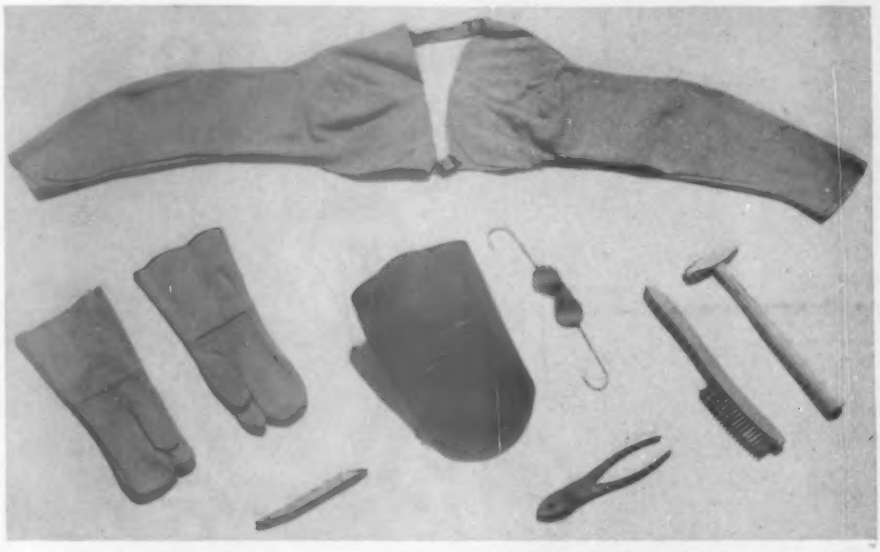


Fig. 3—The items of personal equipment for safe service welding include a welding helmet, gloves, sleeves, goggles, and extra correct dark lenses for the welding hood. Slagging hammer, chisel, pliers and wire brush are essential tools.

which he has to do in the field. He can, for instance, use D-C electrodes to deposit weld metal on a special cutter blade, rooter shoe, shovel tooth, or track roller and then, by simply changing the polarity of his machine, employ an A-C type hard-facing electrode. Through skillful use of the controls for current and polarity, the operator can weld a wide variety of materials ranging from light fender-type 16 gauge sheets up to the thickest and heaviest of plates.

An enclosed body, like the one shown in Fig. 2, gives protection against weather conditions and renders the welding equipment better adapted for field movement, storage of accessories and general compactness.

Electrode Types

Many different kinds of electrodes may be used with a portable welding outfit, but a few general types in a range of four sizes will suffice for the average run of welding and for the average serviceman. For most field purposes, only four types of electrodes will be needed. These are:

(1) An all-purpose type which can be used in any position and where the fit-up ranges from perfect to very bad. Such an electrode is AWS E-6012, an all-position D-C straight polarity electrode of the shielded-arc type, often referred to as a "poor fit-up electrode" because of its ability to bridge wide gaps.

(2) A special electrode for vertical and overhead welding. AWS E-6010, a heavily coated, mild steel, D-C reverse polarity electrode, is the best adapted of the shielded-arc all-position types for vertical and overhead welding.

(3) A high-tensile, general purpose electrode which can be used for welds requiring great strength or on unusual steels which seem to require a high alloy electrode.

(4) A hard-facing electrode.

The above list may be lengthened by AWS E-6020 and E-6030 electrodes (heavily coated, mild steel), which should always be added if the serviceman knows he is going to do a large amount of welding in the flat position or on horizontal fillets. Such electrodes are especially designed for positioned, downhand welding; they are faster melting and will save enough time to be well worthwhile on

Fig. 2 — The enclosed-type portable welding unit provides weatherproof protection for welding machines, electrodes, tools, accessories and the serviceman's personal equipment.

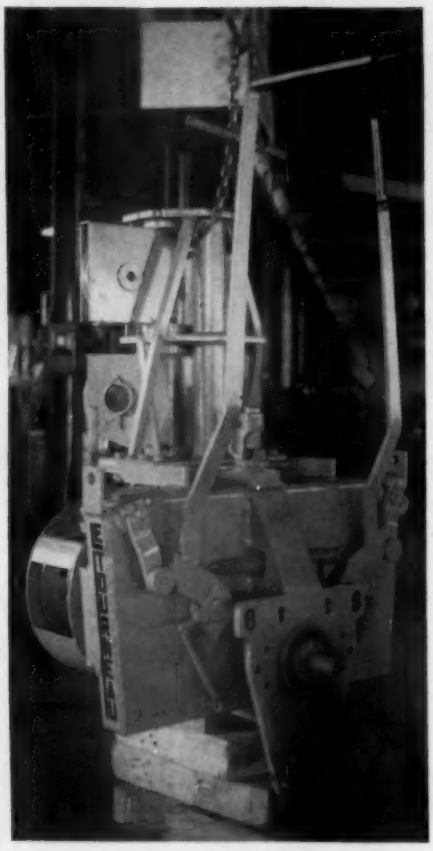


Fig. 4—The welds which fasten the cast neck structure (through which the spring passes) to the fabricated main case of this unit tell the serviceman that the neck is a weldable steel casting.

a good sized job. E-6020 is used for the producton of fillet welds in the flat or horizontal position, while E-6030 is for flat position grooved butt joints.

Electrode Sizes

The serviceman's regular supply should include electrodes of $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$ and $\frac{7}{32}$ in. diam for a welder with the capacity previously described. Usually, the serviceman should not use an electrode of greater diameter than the thickness of the material to be welded. Following this general rule, a weldor should choose the largest rod which will penetrate deep into the bottom of the particular joint he is going to weld, or the largest rod he can handle in the position in which he is going to weld. For flat welds, for example, he might use $\frac{3}{16}$ or $\frac{7}{32}$ in. electrodes, whereas if the same size welds were vertical or overhead he could not use over $\frac{1}{8}$ or $\frac{5}{32}$ in. electrodes.

Most service work will probably be done with $\frac{5}{32}$ in. or $\frac{3}{16}$ in. electrodes.

Other Equipment

Every welding operator should have at least the items of equipment shown in Fig. 3: an arc welding hood with a protective lens of suitable shade, a supply of cover glasses to protect the dark hood lens, safety goggles, heavy leather weldors' gloves, leather arm and sleeve protectors, a welding slagging hammer, a small pointed chisel and (usually) a heavy pair of pliers. A sledge hammer, a ball-peen hammer and a cold chisel should also be included.

The oxy-acetylene flame-cutting and heating equipment needed consists of oxygen and acetylene cylinders, pressure gauges, a length of hose for each cylinder, a torch with a heating tip and a cutting tip, a torch lighter and cutting goggles. The welder truck shown in Fig. 2 has plenty of space for the storage of such a flame-cutting outfit and gives it perfect protection from weather.

This oxy-acetylene equipment can be used for preparing jobs for welding by cutting out old welds, veeing out cracks, cutting new pieces to fit, etc. It may also be used for heating and bending parts to be joined, for preheating parts which need to be preheated for proper welding, or for burning oil, paint or dirt off the area where the welding is to be done. These represent only a few of the large variety of uses for a cutting and heating outfit on repair jobs in the field.

It is now necessary to consider the work to be welded. Certain materials have welding limitations of which the serviceman must take account when he gets on the job. Some of these limitations are described below:

Cast Iron

Cast iron may be welded by special procedures and electrodes, but the ordinary arc welding serviceman, equipped as previously described, will not usually find the arc welding of cast iron practicable. A weldor who has had some experience and training in welding with an oxy-acetylene torch might be able to braze broken cast iron parts. Brazing, however, almost invariably requires special preheating and slow cooling in order to get a good job. Hence it is often more practicable for the welding serviceman to make a new part from steel, welding it out of standard plates and angles and other parts which can be purchased.

A part that has been redesigned and welded by the serviceman from steel will almost surely be stronger than the original cast iron piece, and (unless replacement parts are very easy to get) the redesigning and welding will take less time than an attempt to effect the repair by welding the cast iron.

Not all castings are cast iron. Many steel castings are being used in welded machinery today, and these are readily weldable. The serviceman can distinguish between cast steel and cast iron in several ways. First, if the casting itself is welded to the equipment (see Fig. 4), then it is a weldable steel casting and can be repaired by arc welding in the same way that any piece of welded equipment would ordinarily be repaired. Secondly, a cut along the break in the casting, made with a hammer and chisel, will usually indicate whether the casting is weldable steel or cast iron.

Copper and Its Alloys

Copper, brass, bronze, pot metal and some other non-ferrous alloys can hardly be welded with the equipment described above. Though the experienced operator can often use the oxy-acetylene welding torch to make repairs with special rods, the average serviceman should not try to weld these materials.

In general, the welding of non-ferrous metals requires training in special procedures.

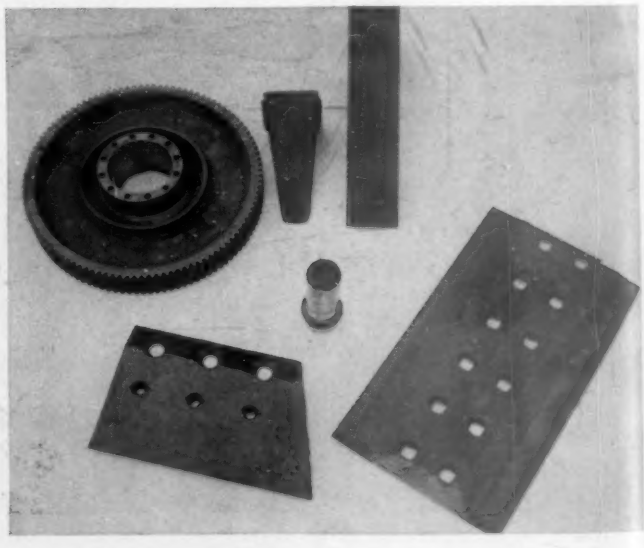


Fig. 5—Each one of these parts has been hard-faced or welded, yet none of them would be readily weldable in the field because each part has been heat-treated after welding to give it special hardness or strength.

High Carbon Steels

Tool steels and other specially alloyed steels may not be weldable. The serviceman will learn to recognize such steels, either by the part of the machine and what it does, or often by the type of break shown. It is usually safe to assume that any part which was welded on in the new machine can also be welded in the field. The exceptions to this rule will be noted later. Very hard materials such as high carbon steels or alloy steels may often be welded, but they will almost always require special welding procedures, including preheating.

In general, the question of whether a part is weldable or not may be answered by checking the following questions:

(1) Has it been welded before? If so, it probably can be welded in the field, unless it happens to be a heat-treated part or a special structure such as a blade or gear.

(2) Is it made of a common structural shape such as an angle, channel, plate, I-beam, Z-beam, T-iron, etc.? If it is an ordinary structural member, it probably can be field welded. Many riveted structures found in heavy machinery are made of ordinary structural steel and can usually be welded.

(3) If it is a casting, has it been previously welded? If so, it will probably be weldable in the field.

Non-Weldable Parts

(4) Is the part a special cutting or wearing part such as a rooter point, a cutter blade, a bucket tooth, a runner rail, a ground plate, a track roller or any other part which is likely to experience considerable wear? If so, it may be an alloy steel and may or may not be readibly weldable. Those parts shown in Fig. 5 have all been welded but would not usually be welded in the field because of the heat treatment needed after welding for strength or hardness.

An examination of how the part is made and where it has been fastened will often show that it has been welded or hard-faced before. Or striking the part with a chisel may give some indication as to its hardness.

(5) Is it a rapidly running part such as a gear or a shaft with gears on it? If so, has it been heat-treated? Heat-treated parts may be built up sometimes, but carburized parts are as difficult to weld as tool steel. Ordinarily, hardened or fast operating parts—sheave wheels, bushings, etc.—present very tough welding problems. A group of such fast operating parts is shown in Fig. 6.

If absolutely essential, a weld may be made on such a part as a temporary method of "getting by" until the replacement part can be obtained. Usually, though, a replacement is a much safer and better practice than an attempt to weld one of the parts in Fig. 6 as a permanent repair.

Welding of shafting (see Fig. 7) may sometimes be done by using the best methods of joint preparation (to be discussed in a later article) and by preheating, but broken axles should not be welded. The welding only weakens the adjacent area and invites the axle to break again.

Serviceman's Responsibility

While welding constitutes only a part of the numerous things which a good serviceman must know, it nevertheless constitutes a very important part. The serviceman must, of course, have the skill required to do high quality, dependable work. In addition, his job is one which requires considerable judgment. He is the one who must decide what method of repair will be used, and he can't afford to make a repair which will prove unsatisfactory.

The serviceman should never be tempted into making repairs that he doubts will be satisfactory. Whenever there is any question in his mind as to whether or not a repair job will hold, he should have a conference with the owner of the equipment and tell him just what he thinks and why. If the owner then wants him to go ahead and make a repair of a temporary or doubtful nature, let him clearly understand that it is his decision and not the serviceman's.

Another part of the serviceman's job is to practice the very best habits of workmanship and skill that he knows. He is in a position of considerable responsibility to both the person whom he is representing and the man whose equipment he is servicing. By being a first class mechanic and workman, by working accurately, thoroughly, efficiently and without mistakes, he is serving best the interests of all concerned.

In his next article, to appear soon in THE WELDING ENGINEER, *Mr. Brooking will discuss preparations for welding, including cleaning methods, edge preparation, lining up, planning to avoid distortion, positioning, preheating, selecting electrodes and adjusting the welding machine. He will also give the four general rules which hold for all welds.*

Fig. 6—Parts such as these—hard, fast operating or load carrying parts of a machine—should not be field welded. They may be pulled out of shape or weakened through softening at the welds.

Fig. 7—Parts such as these carry heavy loads and are usually made of special materials. Often they have been specially treated. They should not be welded under any ordinary circumstances.

Types of Electronic Controls

By T. R. LAWSON
Electronics Application Engineer,
Westinghouse Electric & Mfg. Co.

Our war production effort owes much to those "wires in a bottle," the electronic tube that has allowed resistance welding to develop into a precision process and rendered possible its extension to aluminum, brass, bronze and stainless steel. This article discusses various types of synchronous, non-synchronous and stored energy controls.

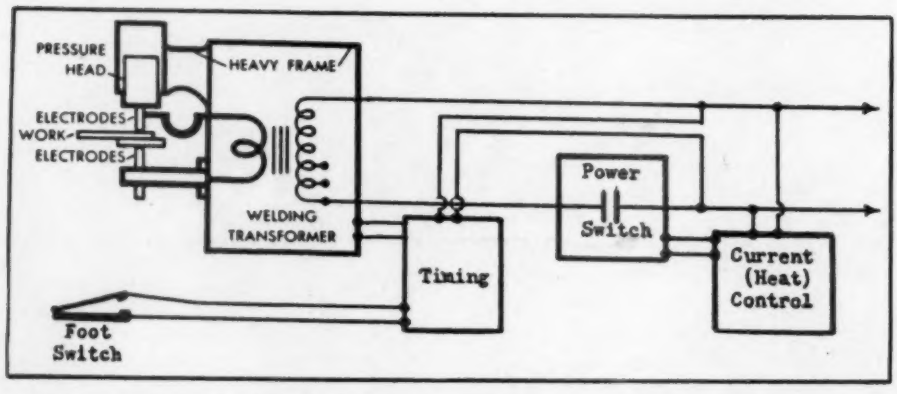


Fig. 1—This diagram shows the principal control functions required on a resistance welder.

THE first resistance welding machines were completely controlled by mechanical means. A foot or hand lever not only closed the power circuit to the welding transformer but also applied pressure to the work as well. The correct time to allow current to flow in order to achieve a satisfactory weld was "guestimated" by the operator. The resistance welding process, therefore, was then largely confined to the coarser sheet-steel structures in which such undesirable welding aftermaths as severe electrode marking, carping, blacking and scaling could be tolerated.

Magnetic contactors, pressure cylinders and mechanical timers were next employed with expected improvement in weld quality and production. There followed, finally, electronic control of resistance welding, which was first introduced about eight or ten years ago. Though industry was, as always, hesitant to adopt a new and entirely different apparatus in place of something which had been "getting by," the growth of electronic control in the resistance welding industry has been almost phenomenally rapid.

Electronic control has enabled resistance welding to become a precision process and made possible its extension to a wide variety of metals and alloys such as stainless steel, brass, bronze and aluminum. It is scarcely surprising, therefore, that electronic control is now being specified for most new resistance welders as well as for bringing older equipment up to date. The constant improvement in consistency of operation, the increased life of the ignitron and accompanying industrial electronic tubes, and the use of heavier, more rugged, industrial types of associated equipment (resistors, capacitors, potentiometers, transformers, etc.) have still further augmented the popularity of electronic control.

Fundamentals

Resistance welding is accomplished by passing a heavy current through two or more pieces of adjacent metal. This material is clamped between copper or copper alloy electrodes, which apply pressure and conduct heavy current to the junction of the metals. The resistance of the metal to current flow develops heat, fusing the metals together.

Resistance welding is done by practically short-circuiting the secondary of a high-current transformer. To prevent burning or warping of the metal and freezing of the electrodes, there must be maintained an accurate control of the following functions: (1) the amount of current passed through the work, (2) the time this current is allowed to flow, and (3) the time and amount of electrode pressure. These principal control

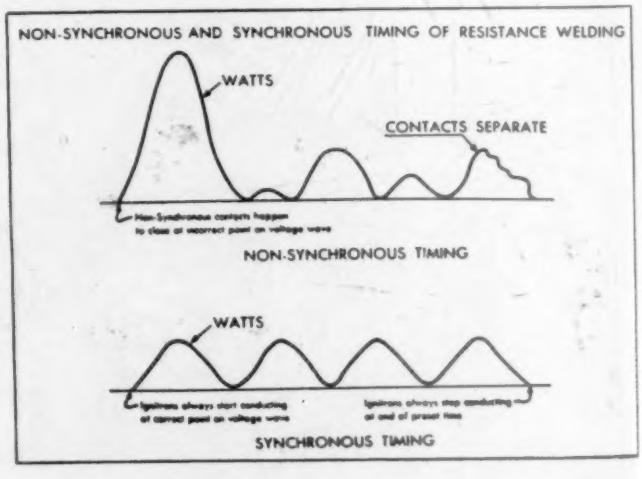


Fig. 2—Random or non-synchronous welding control operation (above) results in transient conditions, causing momentarily abnormal current peaks as shown on the extreme left. Synchronous welding control closes and opens the power circuit at the same point on the voltage wave for every weld, eliminates voltage transients and results in more consistent welding.

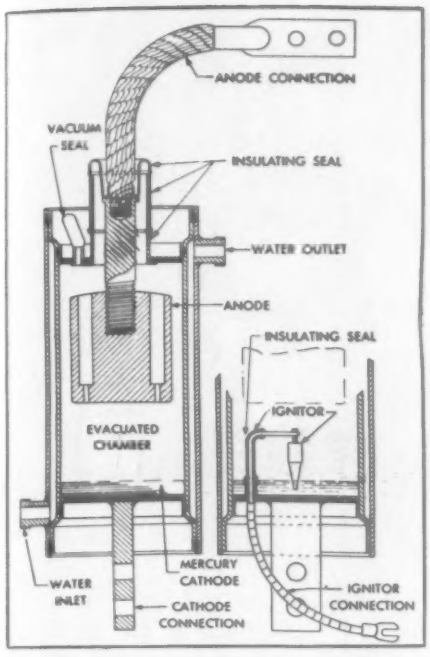


Fig. 3—Electronic controls consist basically of two ignitron tubes such as the one shown in this cross-section. Note the shell which provides water cooling. On the regular controller, overheating of the tube is prevented by means of a thermostatic flow switch.

functions are shown diagrammatically in Fig. 1.

The controls required to regulate the above three functions so as to secure satisfactory welds may be divided into the following broad classifications:

I. Single-phase A-C welding
   a. Non-synchronous
   b. Synchronous
II. Three-phase A-C welding (energy storage principle)
   a. Electromagnetic
   b. Electrostatic or capacitor.

Single Phase A-C Control

A non-synchronous control permits random closing of the single-phase power circuit by push button, mechanical timer or foot switch. Such random operation results in transient conditions that cause momentarily abnormal current peaks as shown in the upper half of Fig. 2. These uncontrolled fluctuations cause changes in the amount of heat supplied to the weld during the first few cycles. Hence there is an undesirable variation in weld quality, especially on short-time welds of a few cycles. On longer welds, those ranging around 20 or 30 cycles, the transient condition is a small percentage of the total energy used in making the weld and therefore does not greatly affect the weld quality.

A synchronous control closes and opens the power circuit at the same point on the voltage wave for every weld so that high transients are eliminated. This condition, depicted in the lower half of Fig. 2, permits more consistent welding to be obtained. Though there is no ironclad rule when to use synchronous control or when to leave it out and use only non-synchronous, certain general recommendations can be followed:

1. The shorter the weld time, the more necessary synchronous control becomes. Non-synchronous control should never be used below about four or six cycles timing if consistent results are to be expected.

2. Certain materials difficult to weld, including aluminum, brass and stainless steels, should always be welded with synchronous control.

3. When highest quality welds are required, either for uniform spot size and strength or good metal surface appearance in any metal, synchronous control must be used.

4. Non-synchronous control is used when minimum first cost of equipment is more important than highest weld quality, principally for mild steel and for welds requiring long-weld-time periods.

Non-Synchronous Control

The most common electronic control unit for non-synchronous A-C welding functions as a single pole ignitron tube contactor and is used to make and break current as high as 8,000 to 10,000 amp. It operates rapidly, without arc, noise or moving parts, and may be applied on any A-C resistance welding machine (within its rated limits) as the line contactor connecting the transformer primary to the A-C current source.

The heart of this and all other electronic controls which handle the heavy power current of A-C resistance welders consists of two ignitron tubes. A cross-section of an ignitron tube is shown in Fig. 3. Each tube passes alternately ½ cycle of A-C current to the welding machine transformer primary as long as the ignitor circuit is energized. Selection of ignitron tube size is based upon the maximum current drawn and the duty cycle imposed. Fig. 4 shows such a control (small cabinet at upper right corner) interrupting the current to a large hydromatic welding machine at the rate of 600 spots per minute.

Some of the advantages of the ignitron tube over mechanical contactors are the extremely fast speeds at which it can operate (makes and breaks currents of several thousand amp readily at 600 times per minute), no moving parts, accuracy of timing, and the smooth control given over the amount of current passed by the tube.

When ignitron tubes are used to handle the line current to a resistance welder, either in non-synchronous or synchronous control, an electronic current (heat) control device can be employed to allow proper welding of various kinds and thicknesses of metals. Such a heat control employs two small thyratron tubes used to make or break the ignitor or firing circuit of the ignitron power tubes. Control of the amount of current

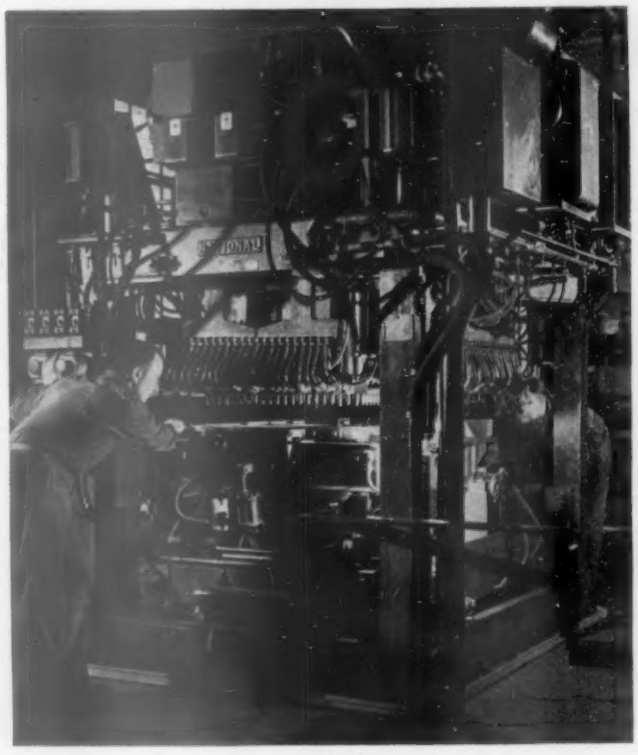


Fig. 4 — Seventy to 100 refrigerator cabinets can be welded per hour by the use of this hydromatic machine, which has three 100 kva transformers. One hundred thirty-eight welding guns join back sheet to cabinet in thirteen seconds.

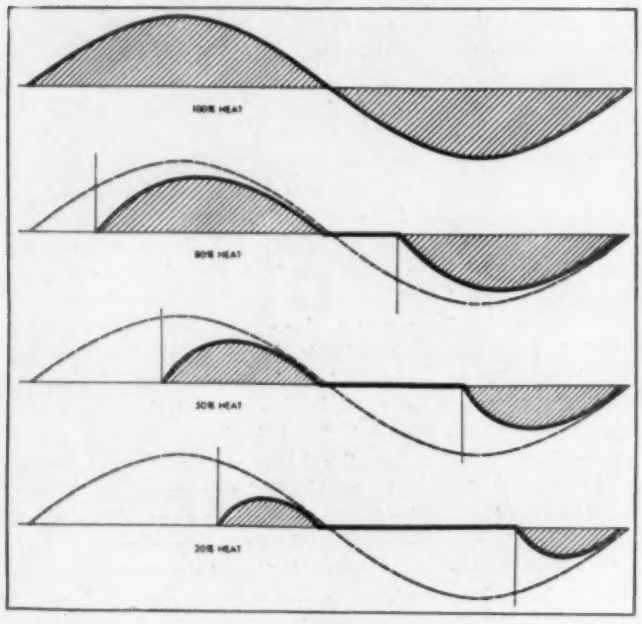


Fig. 5—Various degrees of heat control can be obtained by delaying or advancing the firing point on the current wave as depicted here.

passed by the ignitron is achieved by phase-shifting the thyratron grid voltage with respect to the line voltage. This grid voltage is the resultant of a resistor-reactor circuit. By varying the amount of resistance in the grid circuit by means of a potentiometer the phase positions of grid voltage with respect to the line voltage may be shifted, thereby advancing or delaying the point during any half-cycle at which the thyratron fires and allows the ignitron to pass current. Fig. 5 shows the various degrees of heat control obtainable by delaying or advancing the firing point on the current wave by this method.

The simple ignitron control previously described accomplishes one of the primary control functions needed in good resistance welding: that of applying and controlling the amount of current to the welding transformer. There still remains to be controlled two other primary functions requisite to good welding — the duration of weld current and the electrode pressure and sequence.

Timing Weld Currents

Certain resistance welders use manual or motor-operated electrodes and properly timed cams to start and time the weld current. On such machines, electronic weld timers are not required. With air or hydraulically operated electrodes having solenoid operated valves, weld timers are employed for the purpose of timing the duration of current flow and also for timing the welding machine electrode sequence. The degree of electrode pressure is controlled by pressure regulators normally furnished with the welding machine.

An electronic weld timer consists of one or more small thyratron tubes acting to operate small, lightweight, fast-operating relays. The relays, in turn, control the primary line contactor (either electronic or magnetic) and the welding machine head solenoid valve. Normal timing intervals in the range of 3/60 to 6 sec. are accomplished by adjusting resistance in a resistance-capacitor time delay circuit applied to the grid of the small thyratron tubes. All or any number of the functions listed below may be controlled by such an electronic timer. Each function usually requires one thyratron tube and one relay, with accompanying adjusting potentiometer. The functions are:

Squeeze time: The time from application by the electrode until the application of welding current.

Weld interval: The total "heat" and "cool" times (or total welding period) when welding by the pulsation method. "Heat time" is the time that the welding current flows between interrupted periods, while "cool time" is the time that the welding current is interrupted between heat times.

Hold time: The time that pressure is maintained at the electrodes after the current is cut off.

Off time: In repeat welding, the time that the electrodes are separated from the work piece.

A complete timing cycle involving all of the above functions is shown diagrammatically in Fig. 6. A weld timer to handle all of these functions requires a cabinet size of only 12 by 12 by 17 in. An open view of such a timer is shown in Fig. 7.

A-C Synchronous Control

In A-C single-phase welding, the term "synchronous" is generally used to include several combinations of power tubes and control elements for both spot and seam welding. In all cases, the control is so arranged that the firing point of the ignitron power tubes cannot be advanced ahead of the zero point on the A-C supply current wave. In addition, a weld timing circuit is incorporated on all synchronous controls (normal range of time 1/60 to ½ second), and therefore the weld time function need not be supplied by a separate control item of the type outlined for non-synchronous control. The sequencing of the welder electrodes is handled by a small electronic sequence timing panel. This item is separate from the main synchronous control. Its construction and function are identical with the non-synchronous weld timer previously described except that the weld time function is not required.

The application and advantages of synchronous control have been discussed earlier. A complete line of synchronous control combinations is now offered by electrical manufacturers for both spot and seam welding.

Seam Welding Timers

There are two standard types of seam welding timers on the market, one partially mechanical and the other fully electronic. The partially mechanical seam welding control has chain or disc timing such as is shown in Fig. 8. There is a pinhole in the timing disc for each half cycle. Pins inserted in the disc pass through a magnetic pick-up, and the voltage impulses from this determine the number of half cycles in which the current flows. Pins omitted determine the half cycles in which the current is off.

While work is rolling through seam welding electrode wheels, there is thus a stitching effect, with "heat" being applied alternately "on" and "off," and a row of overlapping spot welds is made. Operation will continue as

Fig. 6—A complete timing cycle of an electronic sequence timer.

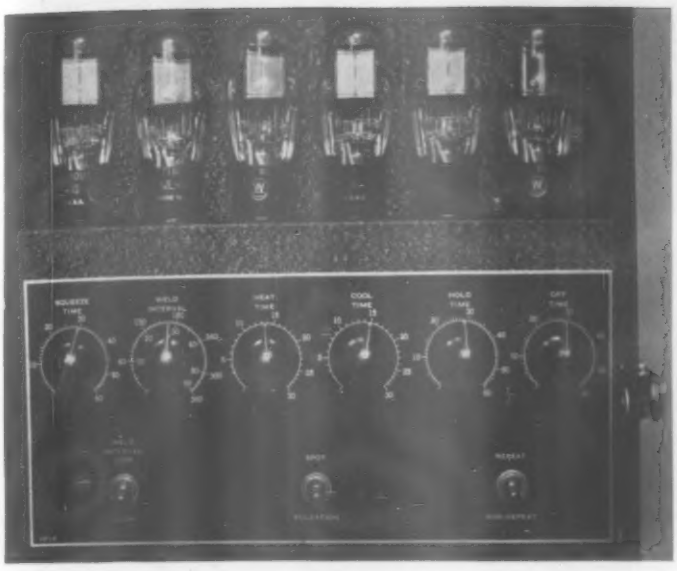
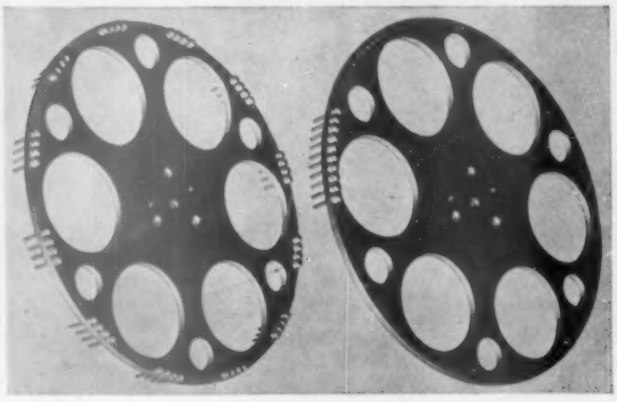


Fig. 7—Open view of a weld timer to handle six timing functions. The cabinet size is 12 by 12 by 17 in.

Fig. 8 (below)—Seam timing discs arranged at left for two cycles "on" and three cycles "off" and at right for five cycles "on" and 55 "off."



long as the operator presses the switch which keeps the control running.

The other type of seam timer is shown in Fig. 9. This unit is completely electronic and does not have the mechanical pin-timing disc or chain. In addition to timing seam welds, this unit is also arranged to time straight spot welding and pulsation welding.

The chief advantages of the completely electronic timer are its extreme flexibility and ease of setting. To change timing, a dial is merely turned to the desired number of cycles "on" and "off." Moreover, conversion to spot or pulsation welding is easy, whereas the disc or chain type is made only for seam welding. The partially mechanical control, however, has the merit of lower price, is less complicated and is an excellent unit for production jobs.

Energy Storage Control

All of the discussion so far has been concerned with single-phase A-C welding in which the welding transformer primary current is taken directly from the A-C line. Since the resistance welding transformer has practically a dead-shorted secondary winding, high kva demand is taken from the supply. The load is at very low power factor, which also greatly complicates the problem of energy supply.

To help reduce this peak kva demand and provide other desirable features not found in straight single-phase A-C resistance welding, a new method of welding was introduced in the United States about three years ago. This is the energy storage or stored energy system, used at present primarily for the welding of aluminum.

The basic principle of energy storage control is to draw energy slowly from a three-phase line and store it until the weld is made. Since the energy is taken from the line comparatively slowly, the instantaneous peak of current taken in the straight A-C method is avoided. In some cases, the energy storage method has reduced peak kva to as little as 1/5 or less of that taken by an equivalent A-C method.

There are two general types of energy storage control now available:

1. The electromagnetic type, which stores energy in the iron core of the welder transformer.
2. The capacitor type, which stores energy in a bank of capacitors.

Electromagnetic System

The overall principle of operation of the electromagnetic type may be understood by referring to the simplified diagram, Fig. 10. D-C power for the welding machine is furnished by a three-phase ignitron rectifier. When the electrodes are closed and apply pressure to the work, the contactor is closed. The current then builds up in the primary of the welding transformer. When it reaches the point for which the current limiting relay is set, the relay operates to open the contactor. The rapid decay of current in the welding transformer primary causes a high inductive kick (current) in the secondary, and it is this current which makes the weld. If the current limiting relay is accurate, the identical amount of current will be produced in every spot weld, regardless of line voltage fluctuations.

Capacitor Type

The other energy storage equipment, the capacitor type, can be described from the diagram, Fig. 11.

Fig. 9 — Circular seam welder used to give a water-tight seal on clothes washer tubs. The upper Cupaloy wheel is shown just before contacting the tub. To the left is the cabinet containing the fully electronic seam welding timer and heat control.

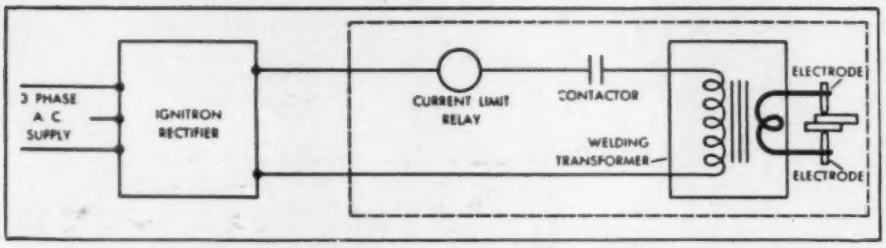


Fig. 10—Electromagnetic system of energy storage control.

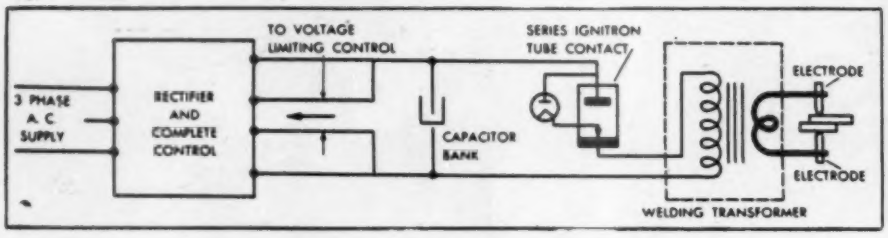


Fig. 11—Capacitor system of energy storage control.

Again, energy is taken comparatively slowly from a three-phase A-C line and rectified to furnish D-C to charge up a large capacitor bank. Instead of a current limiting relay, however, we have an electronic voltage limiting device which stops the rectifier charging when the predetermined voltage setting has been reached. The charge voltage can be set from 1,000 to 3,000 volts, D-C. This charge is kept as long as necessary on the capacitor bank by a trickle charge scheme. When the operator presses the initiating switch to make a weld, the series ignitron is allowed to fire, discharging the capacitor bank into the welding transformer and giving one unidirectional current pulse for each spot. If the same capacitance and voltage settings are maintained, the current pulse is the same for each spot, regardless of line voltage fluctuations.

Energy Storage vs. A-C Control

A-C single-phase welding is being used on both ferrous and non-ferrous metals such as aluminium, whereas energy storage is used primarily for aluminum. The first cost of the A-C single-phase control is much lower than that of the energy storage, while it is also simpler in design and construction.

Energy storage control, however, has proved advantages. It provides a balanced three-phase load with much lower peak kva demands and with improved power factor. Smaller conductors may be used for power supply, making possible a lower wiring cost and permitting greater flexibility in rearrangement of equipment. In welding aluminum for the aircraft industry, more consistent results are claimed because: (a) the weld is made with measured energy, (b) line-voltage variation does not affect the energy to weld, (c) electrode "pick-up" is less and electrodes longer lived, (d) a forging action which helps to prevent cracks can be applied to heavier gauge welds.

Whereas A-C single-phase control is nearing its final perfected stage, the development of energy storage control is far from completion. Its present rather complicated design (quickly developed because of the need for control in the aircraft industry) will undoubtedly be greatly simplified, and the initial cost reduced in the not-too-distant future.

★ ★ ★

Welded Ships Can Take It!

IN SPITE of bearing the neutral Argentine flag, the tanker *Victoria* was torpedoed twice on a trip to New York. When 300 miles off Cape Hatteras, the 12,500 ton tanker was hit 30 feet aft amidships by the first torpedo. Her all-welded hull stood staunch, and the bulkheads and tanks were unbreached.

Fifty minutes later another torpedo smashed portside, causing the Captain and 39 of the unhurt crew to pull off. They were picked up two nights and a day later by a U. S. warship, which informed them that the torpedoed vessel was still afloat.

The *Victoria* arrived in New York harbor under her own power. Welded construction, it was held, was largely responsible for keeping the tanks and the bulkheading from breaking open.

Courtesy, The Lincoln Electric Co.

Argentina's unsinkable "Victoria." After being twice torpedoed, she is now back in service.

★ RESEARCH

The Hardening Flame

★ **Part Two—Stationary, progressive and spinning methods of flame-hardening are herewith discussed. This series of three articles, designed to refresh the memories of those already familiar with flame-hardening, should also serve as a useful guide for the newcomer in this field.**

By **CLYDE B. CLASON**

Modern war, although creating an unprecedented demand for steel parts capable of withstanding the intense batter and wear of military service, has at the same time made it more and more difficult to obtain such strengthening alloys as nickel, chromium and tungsten. Hence flame-hardening, which facilitates surface-hardening of plain carbon steels to a degree permitting their substitution for alloy steels, has increased vastly in importance during the past year of bitter warfare in all parts of the globe.

Because of the extreme timeliness of the subject, a series of three articles was written to present a non-technical outline of basic principles and technique. Part One, published in the January issue of THE WELDING ENGINEER, *discussed the metallurgical changes which occur when an iron-carbon alloy (steel) is heated to high temperature and then rapidly quenched. The present article will cover the equipment and methods employed for hardening both flat and curved surfaces, while the third and final installment will be devoted to the various kinds of ferrous materials which can be successfully flame-hardened.*

FLAME-HARDENING is a process for hardening the surface of a ferrous material by heating it to high temperature with an oxy-acetylene flame and subsequently administering a rapid quench to produce a surface layer of hard martensitic structure. Such hardening can be accomplished either manually or mechanically, with a single torch and one quench or with an elaborate flame-treating head having several rows of flames followed by a row of quenching holes. Consequently, there is a wide variation in the equipment available.

"Special" and "Standard"

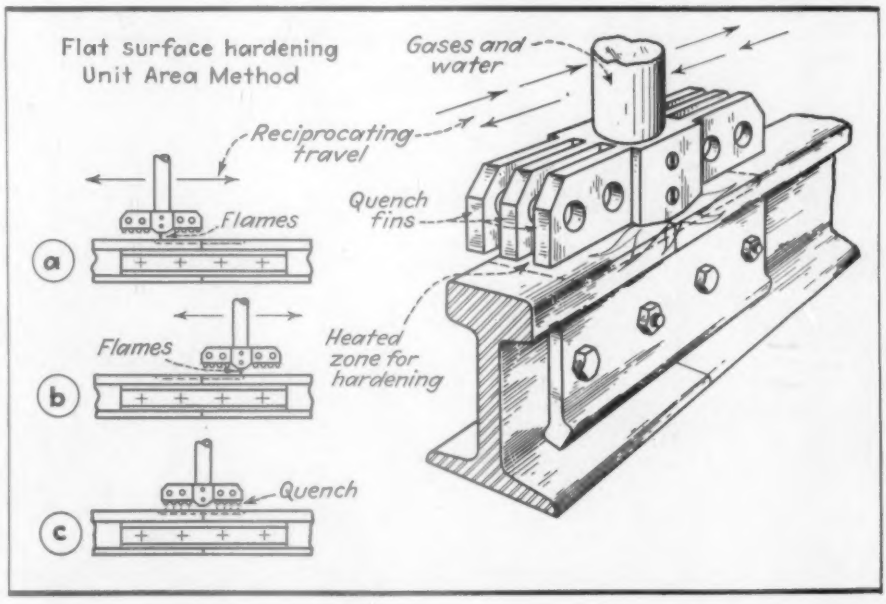
Special heads may, of course, be built to order for any application, virtually the only limit being the cost. Standard or "stock" flame-hardening heads, however, are available for hardening many different sizes and types of flat and cylindrical surfaces. By inserting various lengths of removable tips in the standard heads, considerable flexibility can be secured.

While on the subject of equipment, it might be stated that the portable cutting machine may be readily adapted for progressive hardening of flat surfaces and that most lathes can be quickly converted into machines for "spinning" cylindrical surfaces for hardening.

As stated in Part One of this series, one of the chief advantages of the flame-hardening process is its adjustability to suit the particular conditions of the work. If a comparatively small area is to be treated, the hardening can be done manually with a standard welding torch. A large flat surface necessitates the employment of a heating-and-quenching head mounted upon a traveling carriage, the rate of travel being mechanically controlled. Cylindrical objects, whether long or short, large or small, must be mounted so that they will rotate past the flames of one or more heating torches. The speed of rotation may be either fast or slow, and the torches either stationary or moving parallel to the axis of revolution.

To these various methods of flame-hardening, there have been applied names according to the surface shape to be hardened. These names may appear somewhat confusing when they are encountered for the first time, so the following outline is offered to help to make the picture more clear:

Small areas: spot, unit area.
Large flat surfaces: progressive.



Courtesy, American Machinist

Fig. 3—Unit area method as applied to the hardening of rail ends. Note the reciprocating travel of the flames. Railroads are making extensive use of this process for hardening rails to resist the battering action of the car wheels at the rail joints.

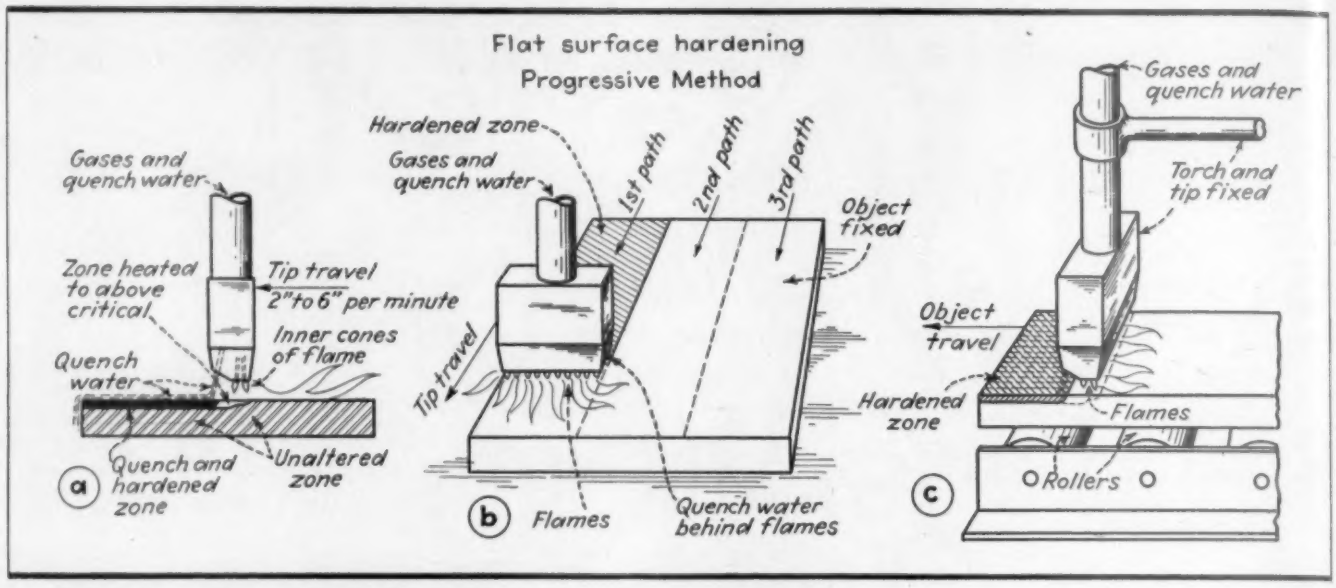
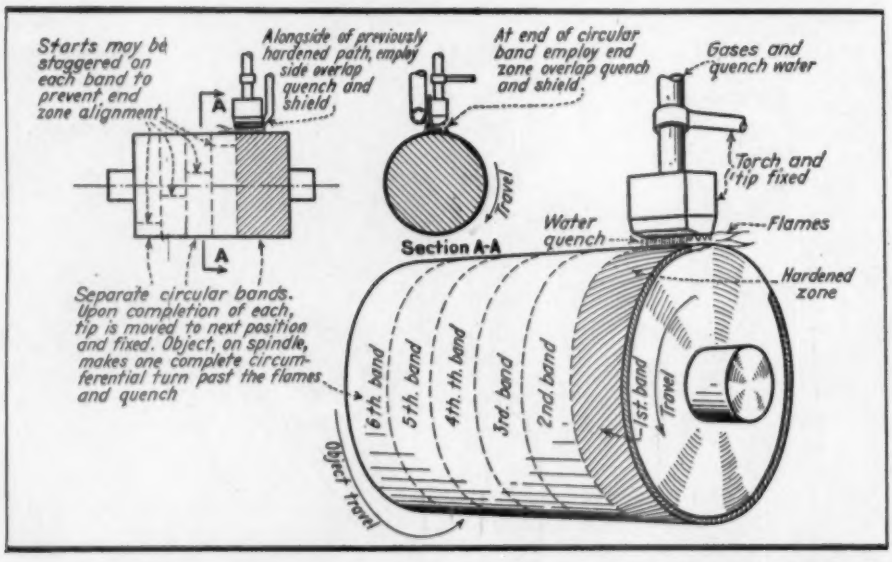


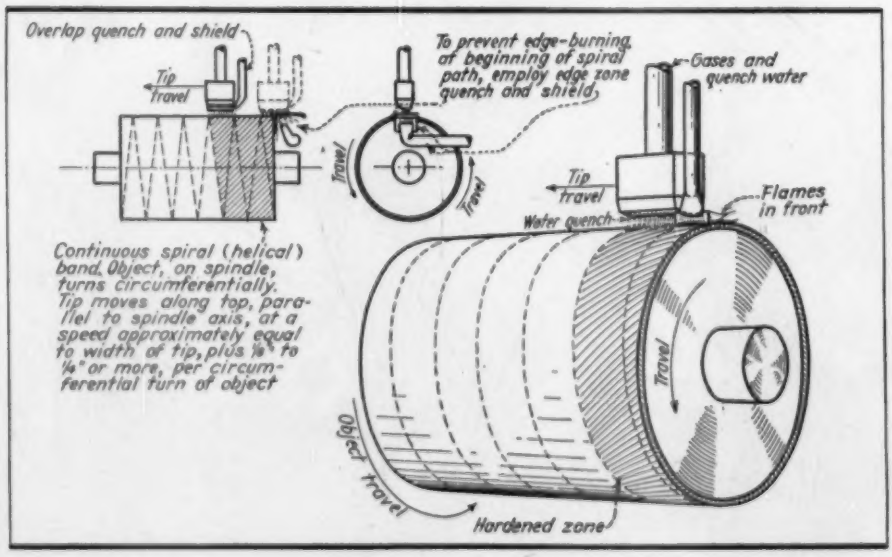
Fig. 4—Flat progressive method. Either the work or the heating tip may move. The quench water is sprayed at a closely calculated distance behind the heating flames.

Courtesy, American Machinist


Starts may be staggered on each band to prevent end zone alignment
Alongside of previously hardened path, employ side overlap quench and shield
At end of circular band employ end zone overlap quench and shield
Gases and quench water
Torch and tip fixed
Flames
Water quench
Section A-A
Travel
Hardened zone
Separate circular bands. Upon completion of each, tip is moved to next position and fixed. Object, on spindle, makes one complete circumferential turn past the flames and quench
6th band
5th band
4th band
3rd band
2nd band
1st band
Object travel

Courtesy, American Machinist

Fig. 5—Band progressive method. The various parallel bands are heated and quenched separately. A complete circular band is hardened before the torch is moved laterally in order to harden the adjacent area.


Overlap quench and shield
Tip travel
To prevent edge-burning at beginning of spiral path, employ edge zone quench and shield
Gases and quench water
Travel
Tip travel
Flames in front
Water quench
Continuous spiral (helical) band. Object, on spindle, turns circumferentially. Tip moves along top, parallel to spindle axis, at a speed approximately equal to width of tip, plus ⅛" to ¼" or more, per circumferential turn of object
Travel
Object travel
Hardened zone

Courtesy, American Machinist

Fig. 6—Spiral band progressive method. The torch and quench are moving parallel to the axis of revolution all the while the work is being slowly turned.

Cylindrical surfaces:

Two slow-revolving methods: band progressive, spiral band progressive.

Two fast-revolving methods: spinning, progressive spinning.

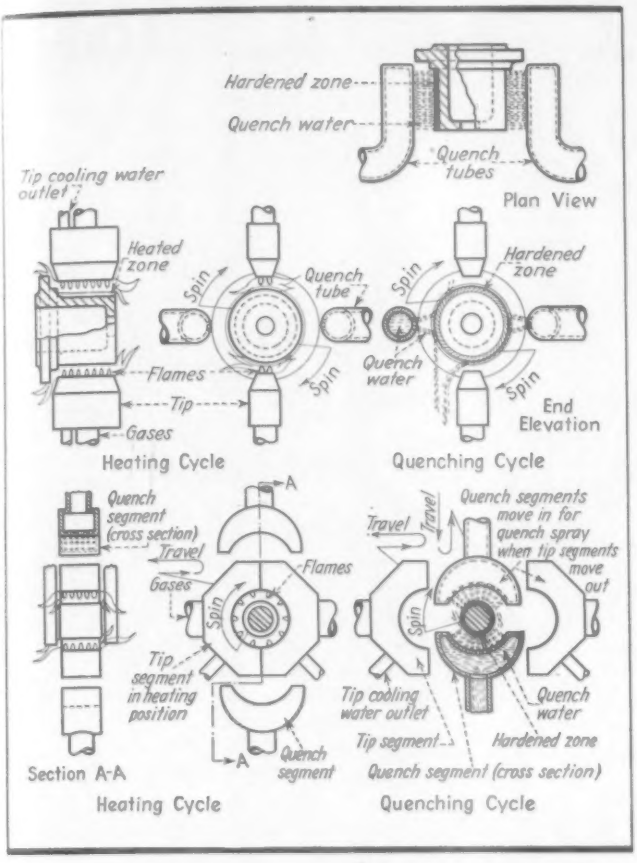
Under another system of classification, there are four general methods of flame-hardening; namely, stationary, progressive, spinning and combination, the last-mentioned term referring to a combination of spinning and progressive motions. This system, though simpler to remember, does not distinguish between those round-surface methods where the work is revolved slowly past the flames and quench jets and those where it is spun at fairly high speed, permitting the entire circumferential area to be heated before quenching.

Stationary Methods

A distinction is sometimes drawn between "spot" and "unit area" methods of hardening, both coming under the classification of "stationary."

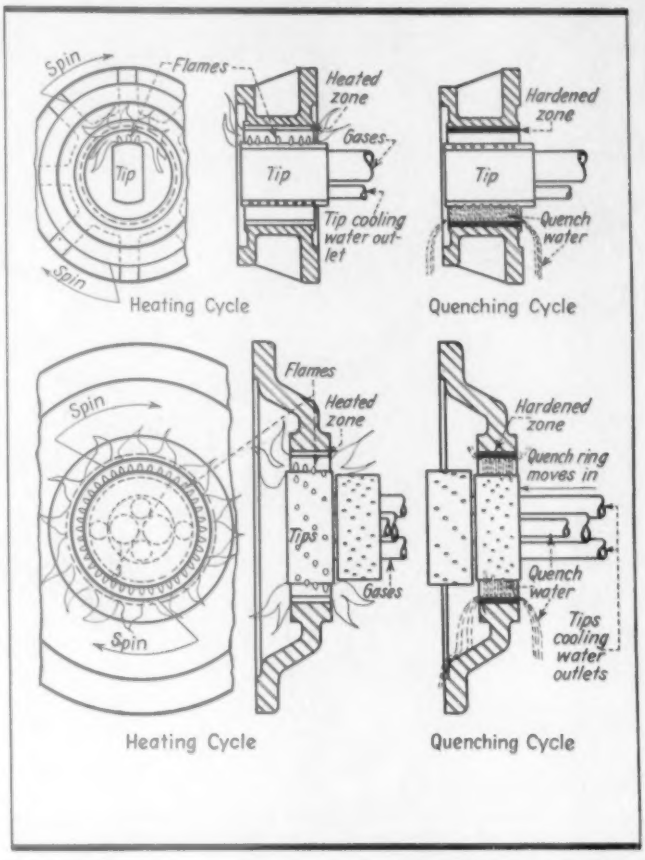
"The spot method," states Magrath, "is the simplest flame-hardening procedure. It is applicable to small or local areas seldom more than 4 sq. in. in size and more frequently on areas of less than 1 sq. in. . . . Standard oxy-acetylene welding torches may be employed with single-flame heating tips for areas not over ¼ sq. in., or two, three or larger multi-flame tips for larger areas."

For adoption to mass production, the spot method can readily be made



Courtesy, American Machinist

Fig. 7—Spinning method. The work is rapidly rotated, and quenching does not occur until after the entire surface has been heated above the critical temperature. The spinning method is readily adaptable to automatic production.



Courtesy, American Machinist

Fig. 8—Hardening inside surfaces by the spinning method. Smaller inside diameters need only one tip (upper illustrations); the circular heating tip and quench ring (lower illustrations) is used for larger inside diameters.

partially or even wholly automatic. Small parts may be placed on conveyor belts and carried at a predetermined rate of travel past the flame and quench, each of which may be applied either manually or automatically. A spray quench may be used, or the flame-heated parts may be dropped into an oil or water bath.

The unit area method differs from the spot method in that it involves larger areas over which the torch is either reciprocated or oscillated backwards and forwards until a particular area has been heated above the upper critical point. The torch is then removed and the surface quenched. Either heating or quenching or both may be made automatic.

Fig. 3 shows the application of the unit area method to harden rail ends. Railroads are making extensive use of this process for hardening rails to resist batter. A rail surface 5 in. long can be heated to hardening temperature in less than two minutes. The quench is regulated to impart a hardness of 400 Brinell to an as-rolled rail of 225 Brinell.

Flat Progressive

For hardening extended areas, the heating and quenching mediums may be embodied in a head which can be moved at a constant speed along the path to be hardened. From the beginning, the portable oxy-acetylene cutting machine has been applied to progressive flame-hardening. The tips used generally have quenching orifices located at closely calculated distances behind the orifices for the heating flames so that the surface is continuously being heated and then quenched. By careful regulation of the flame characteristics, distance of flames from the work, speed of travel and other variables, a uniform hardness may be produced over the entire surface while the core is left in its original state.

Either the work or the torch may move in the flat progressive method, although it is more common practice to have the torch travel across the stationary work, Fig. 4b, than to have the work moving under or past the stationary tip, Fig. 4c.

The depth of the hardened surface is directly controlled through regulation of the rate of torch travel, which may be varied from 3 to 12 in. per min. As stated in Part One, a tip speed of 4 in. per min will give a penetration of $\frac{3}{16}$ to $\frac{1}{4}$ in. and of 6 in. per min a penetration of $\frac{1}{16}$ to $\frac{1}{8}$ in., these general estimates being affected by many variables.

It is important to keep the flames far enough from the work to avoid overheating, which may result in checks or cracks. Also, the quench must be placed far enough behind the flame to prevent interference with the flames or heating, yet close enough to prevent the heated metal from cooling below the critical temperature before it can be quenched.

Multi-flame torches must be water-cooled in order to prevent overheating of the tips and consequent flash-backs. Sometimes the quenching orifices are made to serve a dual purpose, that of cooling both the tips and the heated surface. Tips may also be designed with an internal cooling system which employs an auxiliary water stream.

Tips have been manufactured up to 36 in. in width, making it possible to harden wide areas in one pass. If necessary, however, tips 3 in. wide and under can be used, the hardening being done in a succession of narrow strips. The flow of heat into areas previously hardened can be prevented

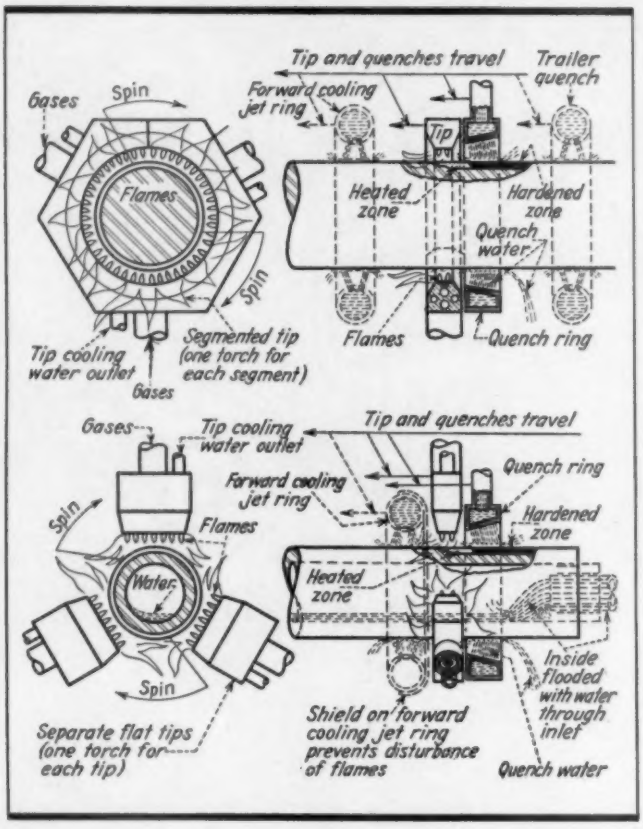


Fig. 9—Progressive spinning method. The tip and quenches travel in a direction parallel to the axis of revolution while the work is being spun. A forward cooling jet ring prevents heat from being withdrawn from the heated zone in advance of the flames, while a trailer quench prevents the hardness from being drawn by a build-up of residual heat behind the hardened zone.

Courtesy, American Machinist

by providing auxiliary water jets at the ends of the rows of heating holes. Though there is of necessity a soft line between two successive passes, it may be held within such narrow limits that it can scarcely be detected with the standard Brinell hardness tester.

Instead of moving in straight lines, the torch head may be mounted on a radius rod and made to describe a circle of any desired diameter. This is still classified as flat progressive hardening because the tip, although moving in a circular path, continues to travel over a flat surface.

Hardening Round Surfaces

Of the four methods for hardening round surfaces, two involve rapid rotation and two involve slow. Two involve lateral movement of the torch head during rotation and two do not. Thus the methods may be distinguished as follows:

Band progressive: slow, hardens parallel bands.

Spiral band progressive: slow, hardens spiral bands.

Spinning: fast, hardens entire surface at once.

Progressive spinning: fast, hardens a continuous spiral.

All of the above four methods are applicable to hardening either external or internal cylindrical surfaces. The progressive methods are applicable to vertical as well as horizontal torch travel.

Band Progressive

Under the band progressive or progressive parallel band method, the object being hardened is mounted in a lathe and turned at a surface speed of 3 to 12 in. per min. past a multiflame heating tip and quenching jet. The flame-hardening head is usually mounted on the lathe carriage tool post and may be moved in a direction parallel to the axis of rotation of the work as shown in Fig. 5. After a complete revolution has been effected, the torch head is moved laterally so as to be in position for hardening an adjacent band. Overlapping should be avoided, which is best done by leaving a space of from ⅛ to ¼ in. between bands. To prevent drawing the hardness at the boundaries of the bands, auxiliary cooling streams should be used at both ends of the row of flames.

The band progressive method is usually applied to cylinders of large diameter, such as rolls, shafts and sleeves, for which it would not be economical nor mechanically practical to employ spinning. Its principal disadvantage is that the hardness may not be perfectly uniform over the entire length, due to the presence of comparatively soft zones between bands.

Spiral Band Progressive

Details of the spiral band progressive method are depicted in Fig. 6. This method resembles the band progressive in that the object is rotated at approximately the same surface speed but differs in that the torch and quench are moving parallel to the axis of revolution all the while that the object is being turned. The speed of travel is so set that the torch tip will move a distance equivalent to its own width, plus ⅛ to ¼ in. or more, during each complete revolution. Thus there is produced a continuous hardened spiral of 2 to 3 in. in width, depending on the width of the tip.

As in the case of flat progressive and band progressive hardening units, auxiliary water jets should be provided at the ends of the rows of heating flames in order to stop heat from flowing into previously hardened areas and thus drawing the hardness.

Overlapping is usually avoided in this method by leaving a narrow band between the successive coils of the spiral. The resulting zones of lower hardness between the passes are usually not objectionable. To prevent burning the edge of the work at the beginning of the spiral, an end-zone quench shield may be employed as shown in Fig. 6.

The spiral band progressive method is somewhat better suited to treating the entire length of a shaft or cylinder than the parallel band progressive method because it eliminates the soft end zones which occur at the starting-stopping point of each band in the band progressive method.

Circular Spinning

The spinning technique eliminates all overlaps or softened zones, producing a uniform surface of fine martensitic structure which may readily be extended to any desired depth of penetration. Circular spinning is the simplest means for hardening cylindrical surfaces and will yield by far the most satisfactory results. Because of its speed, this hardening method is also particularly well suited to mass production. Unfortunately, circular spinning can be applied only to small or at best medium-sized objects. It is best suited for small pitch gears, screws, crankshaft journals, short lengths of shafts, etc.

Details of the circular spinning method are given in Fig. 7. The part is rotated a surface speed of about 1,000 circumferential in. per min. (50 to 125 rpm for objects with diam of 6¼ to 2½ in.) past a heating tip sufficiently broad to cover the entire width of the surface being hardened. For objects of comparatively small diameter, one set of torch tips will be sufficient, but objects of larger diameter will necessitate the employment of two or more heating tips spaced

equidistantly around the work. The multiple tips serve to increase the rate of heating and thereby secure the desired surface hardness with a relatively small penetration.

The flames are allowed to play upon the work for a very brief period, usually less than 1 min. and perhaps as short as 10 sec for objects of small diam. The flames are then either withdrawn or extinguished and a quenching stream is applied. Note that in this method quenching does not occur until after the entire surface has been heated above the critical temperature. The advantages of this are that the flame adjustment, torch positioning and the nature and degree of quenching are not so critical as in other methods and not so apt to interfere with the production of uniform hardness. Moreover, the spinning process is readily adaptable to automatic control.

Instead of a spray quench, an immersion quench may sometimes be used to good advantage. Small gears, for example, may be released automatically from the spindle at the expiration of a predetermined period of time and dropped into a quenching bath. This method of quenching, however, is applicable only to small parts.

The spinning method may also be applied for hardening inside surfaces. For this, the torch tip or heating ring is mounted centrally within the hollow cylinder, which is spun, heated and quenched as previously described for exterior surfaces. Fig. 8 shows the use of both a single tip and of a heating and quench ring unit for objects of large diameter.

Progressive Spinning

The circular spinning method can be used only for objects short enough to be covered by a single set of heating flames. Longer cylindrical surfaces must be hardened by the progressive spinning method shown in Fig. 9. Here the tip and quenches travel in a direction parallel to the axis of revolution. As in the previous method, the work is rotated at a circumferential speed of about 1,000 in. per min. The tip is mounted on a carriage traveling laterally at the usual progressive hardening speed of from 3 to 12 in per min as the work is revolved. Multiple torches are provided, the number depending on the diameter of the object being hardened. Usually a circular head, equidistant from and encircling the circumference of the cylinder, is used. For objects of larger diameters, the heating tips are composed of segments, each operating as a complete unit. This is shown in Fig. 9. A quench ring, or circular quenching stream, flows at a distance of ¼ to ½ in. behind the flames.

Progressive spinning is rapid and superior to either the circular band or spiral methods for hardening cylindrical objects of extended length such as rolls, shafts, liners, fine screw threads, etc. There are no side or end zone overlaps since heating and quenching progress continuously from end to end of the work. The even distribution of heat over the entire surface results in uniform depth and degree of hardness.

A forward cooling jet ring and a trailer quench are often added to the apparatus. These are especially necessary for hollow objects because of the high rate of heat conduction. The forward cooling ring prevents heat from flowing from the heated zone in advance of the flames, while the trailer quench eliminates the possibility of a build-up behind the quench of residual heat which might draw the hardness.

Progressive spinning equipment may also be adapted for hardening the inner surfaces of long cylindrical objects.

Vertical Flame-Hardening

Vertical progressive spinning is favored by many authorities for hardening objects of larger diameter than 10 in. Fig. 10 shows one application. The shaft is being spun in a vertical position, while the flames start at the bottom and progress upward. Since gravity prevents the use of a precooling jet ring, the counteraction of heat flow in advance of the flames presents a rather difficult problem.

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The third and final installment of this series, to be published soon, will discuss the application of flame-hardening to various types of carbon steels, alloy steels, cast steels and cast irons.

Fig. 10—An application of vertical flame-hardening. The shaft-hardening machine shown was made from an up-ended lathe. While the shaft is rotated, the flames progress upward and are followed by a ring quench.

Courtesy, The Linde Air Products Co.

Arc Welded Locomotive Repairs

Shielded-arc type electrodes, especially the larger diameter electrodes, are speeding up locomotive maintenance work to a pace which would not have been held possible a few years ago.

By ARTHUR HAVENS

IT IS difficult for those not in daily contact with arc welding to appreciate the progress made in the development of welding equipment during the past few years. Even those of us who spend every waking hour in the study and practice of the welding art have difficulty in keeping posted on all the new items that appear on the market.

Just a few short years ago, arc welding was considered to be a rather mysterious sort of something capable of joining two pieces of steel together only under perfect conditions. One eighth inch electrodes were the almost universal size, for few shops had the equipment to handle anything larger. In the shop where I first learned to weld, we arranged our own machine. Our current was derived from a steam exciter that was used to excite the coils in the large generator in the power house; for grids we had a nice big barrel of salt water, and we determined our welding current by raising or lowering two copper plates. What a difference now!

Fig. 1—Broken spokes are easily repaired by shielded-arc welding.

Shielded Arc a Milestone

I believe that anyone long connected with welding will agree with me that the greatest single advancement in arc welding came with the creation of heavily coated electrodes —the shielded-arc process. Even the most dyed-in-the-wool bare rod enthusiasts are prone to admit that coated electrodes have something which bare rods can never duplicate. The advantage is especially evident if the job is one that requires one layer upon another, for here, as in no other place, the weldor can witness the ravages of oxidation and slag inclusion.

Many people seem to link shielded-arc welding with fabrication alone. A railroad, however, uses coated rods fully as much for repair work and building up worn parts as for making new parts and articles.

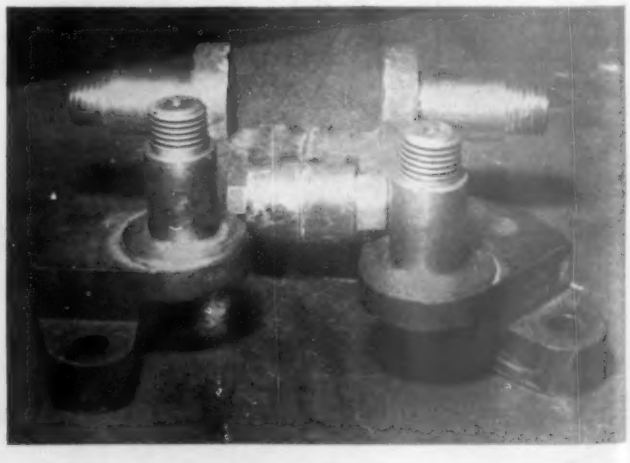
Broken Locomotive Frame

Take, for instance, a job that came up some time ago. A large Mikado type freight engine, recently overhauled and in constant use, broke its frame. The fracture occurred underneath the cylinder saddle some six inches in from the rear of the saddle. The frame was 6 by 12 in. and was covered on the top and one side by the frame fit of the cylinders, so it had to be scarfed all from one side. Arc welding with coated electrodes was the only solution to avoid a lengthy delay.

Locomotive frame castings have the knack of breaking in the most inaccessible places and breaking for no apparent reason. Arc welding is the proper method of repair, but until the advent of the coated rod the welding job accomplished was seldom satisfactory. Now, however, we have exceptionally good luck on steel frame castings, just scarfing them out and welding them with the coated rod.

Here's a tip on cutting out heavy sections preparatory to welding where the frame must be cut from one side. Use a piercing nozzle and cut straight into the frame. This will leave a groove about an inch or so wide at the front of the cut, while the back will be just cut through. Now that the frame has a cut all the way through, it is a simple matter to vee the section to suit. The frame previously mentioned was welded, using

Fig. 2 (right)—New pins were welded to these link bridges to replace pins worn to undersize.



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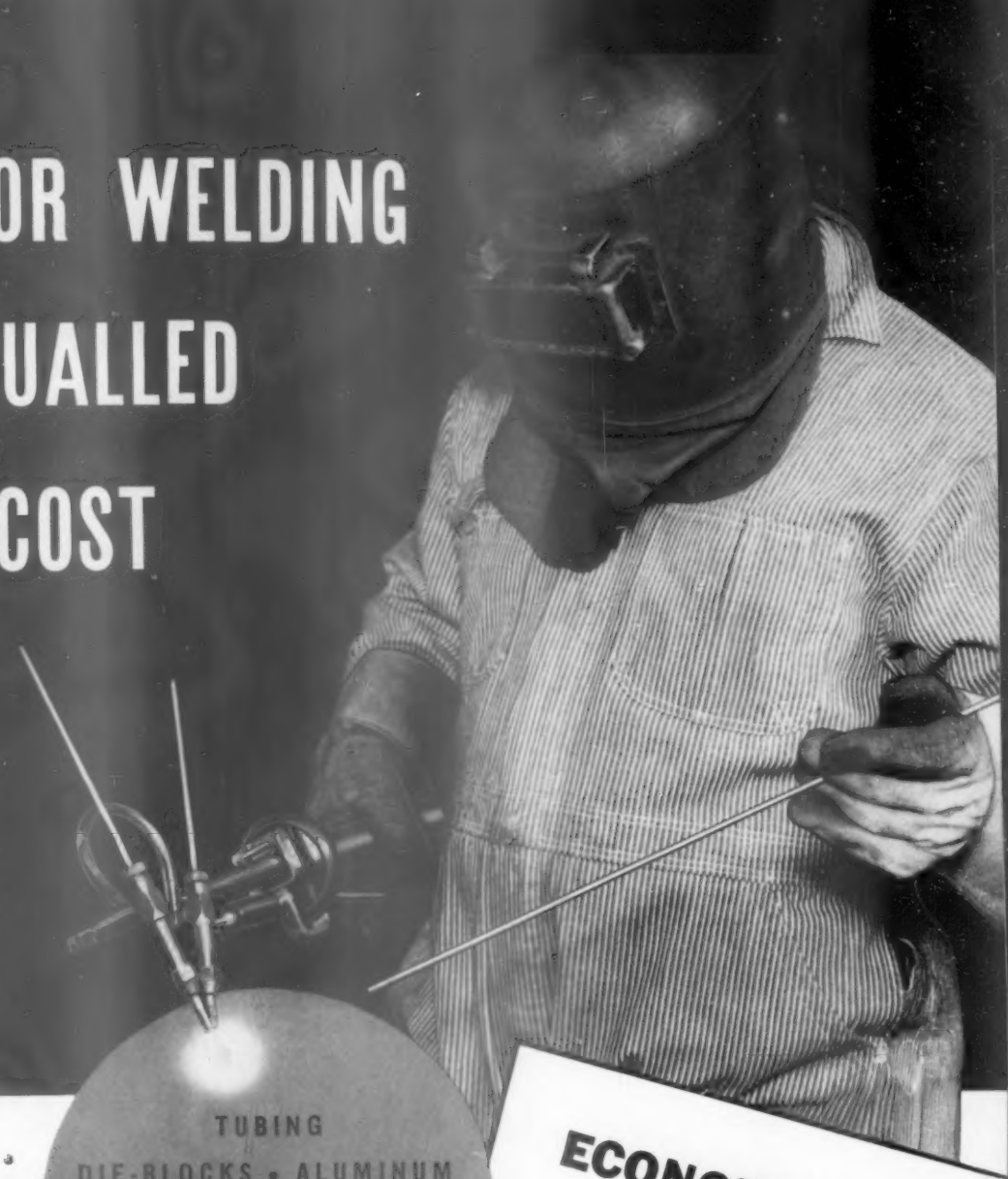

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Fig. 3—Building up a driving box for brazing. The grooves are filled with deposits from a 5/16 in. electrode.

fifty pounds of 1/4 in. electrodes, in about twelve working hours. Each layer of weld metal was thoroughly peened with an air hammer before the next layer was deposited.

Driving Wheel Repairs

What railroad weldor has not at some time or another shuddered with horror at the thought of welding a broken driving wheel hub with the torch! There is no question but that this method of repair makes for an excellent job, but it is surely hot and expensive to demount a driving wheel, build a furnace and weld in this manner. How much simpler to vee out the crack and weld without even taking the wheels out of the locomotive! Let me again stress the need for peening or bobbing; each layer must be peened to compensate for the contraction of the applied metal. Driving wheel spokes and rims are welded in this same manner (Fig. 1) and with the same degree of satisfaction. I am not going to claim one hundred per cent success on these applications, but the good jobs so far outnumber the poor ones as to make the practice acceptable.

Another very important use for the coated rod is for the renewal of some casting or forged part that is either broken or too badly worn to rebuild with weld metal. A splendid illustration of this is the group of worn link bridges shown in Fig. 2.

When the pin on a link bridge becomes badly worn and too far undersize for use, the pin is cut off about one inch from the bottom and scarfed for welding. A piece of soft steel of sufficient size to machine is also scarfed and welded with a coated electrode to replace the worn pin. By building up a layer of weld metal, the bridge may be machined to its original size, saving the delay and expense of making or buying a new one.

Large Diameter Electrodes

In rebuilding worn parts, the use of large diameter coated rods has stepped up production by leaps and bounds. An example is provided by locomotive guides. These get a great deal of lateral wear from the crosshead shoes and are usually restored to standard width when the engine is in the shop for general repairs. Formerly, it was customary to do this work with bare rod, the job taking many hours. Now, however, 5/16 or 3/8 in. coated electrodes are used, cutting the welding time many hours. Care must be exercised in depositing the initial bead along the edge of the guide, which will have a tendency to burn. This danger may be averted, however, by keeping the crater of the weld about 3/8 in. in from the edge and working the puddle out to the edge with a semicircular motion.

Passenger car, freight car and locomotive coupler knuckles are rebuilt with heavy electrodes. The wearing surfaces of the knuckles often require as much as 3/8 in. to bring them up to gauge. One pass with a 5/16 in. electrode replaces this metal, and it can be hammered while hot to fit the gauge perfectly.

Making Heavy Deposits

When preparing our driving boxes for brazing, we fill the grooves of the hub face of the boxes with weld metal in order to avoid the deposition of an excessive amount of bronze. This application calls for a very heavy deposit as oftentimes these grooves are very deep and wide. This practice, shown in Fig. 3, would be entirely out of order with any ordinary size bare rod, but it is merely routine with 3/8 in. coated electrodes and a current of 350 amp. All that is necessary to prepare the deposited surface for brazing is a light grinding, done with a portable grinder. This method makes a solid base for the bronze layer, which is generally about 5/16 in. thick and will wear many hundred thousand miles without rebuilding.

Firebox welding is in a class by itself and requires a treatment too long to mention at this time. The welding of flue beads to the flue sheet with coated rod, however, is such a vast improvement over the bare rod method that a few words will not go amiss. Welding flue beads to the flue sheet has always been a tricky problem, calling for exceptional skill on the part of the operator. Even a skilled weldor would occasionally do such a sloppy job that you could throw your hat in the firebox door and have it hang somewhere on the flue sheet welding. With the coated electrode, the difficulties are largely eliminated, and each flue is neat and uniform.

There is one "must" in preparing flues for welding with coated electrodes. The flue sheet must be free from dirt and scale, and no oil can be left on it. If the sheet is oily, the weldor should dry it thoroughly before attempting to weld, for welds made on a dirty or oily sheet will crack almost as fast as they are made. With a clean sheet and the proper size electrode (1/8 in. preferred), an operator can just about double the number of flues welded over the bare rod method.

The recommended procedure is as follows: Two or three rows of flues are welded down on one side. The operator then moves to another section of the sheet and carries out the same procedure; his dodging around keeps the sheet from becoming overheated in any one spot. When the starting point is cool, the slag is removed from the top and bottom of the half-welded flues. They are then completed by welding the other side.

Welded Fabrication

Welding has so simplified the design of fabricated parts that the engineering department has it pretty soft.

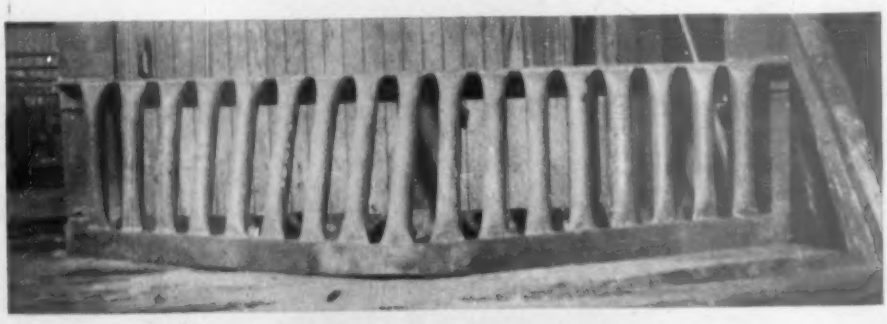

Fig. 4—A weldor made this good looking locomotive pilot in less than 8 hr.

NO. 2 OF A SERIES

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LAST LONGER: Smooth inner walls—with no ridges, waves or scale—means less corrosion and longer life.

LESS PRESSURE LOSS: Because of full effective radius and exact O.D. and I.D. alignment with the pipe, the flow is more efficient and pressure loss is less.

FEWER SUPPORTS NEEDED: Since welded piping weighs less and stands vibration better than flanged systems, few hangers or supports are required.

In place of large drawings covered with minute detail on the layout of rivet holes, bolt holes, laps and flanges and all the other things needed in bolted and riveted assembly, we now get a piece of yellow paper with a few pencil lines here and there and such instructions as "weld here" and "weld here." This holds true in the fabrication of locomotive pilots, smoke stacks, smoke stack extensions, steel grease cellars, grate shaker casting replacing units and a hundred or so other items connected with the repair of a locomotive. See Figures 4 and 5.

Another Example

An order came into the stores department for a double deck bunk for

Fig. 5—Building a locomotive smoke stack.

an engineer's and fireman's quarters at some outlying point. A rough sketch was handed to the welding foreman, and the job was completed within a few hours. The bunk frame was fabricated from pipe welded by the shielded arc.

A great many railroad weldors still experience difficulty using coated electrodes in the vertical position; this can be overcome with practice and the selection of the proper rod and amperage. Of course there will always be some trouble where many weldors must weld from the same source of power. One man, for instance, may have a vertical job in which he would benefit by using reverse polarity, but he must content himself with straight polarity because that is the choice of the other weldors using the same generator. Even this difficulty is now nearly eliminated, for the new all-position, straight polarity electrodes are very efficient in whatever position the job may call for.

Obviously, the heavy coated electrode has found a definite place in the railroad shop, and it is becoming more needed every day.

Brazing Speeds Bomb Output

Fig. 1—Pressing a flange and prefabricated ring of brazing wire into position. The traveling carriage contains three bomb containers.

AT ONE—just one—of our country's many war plants, bombs are being turned out at the rate of 2,400 every day! In this plant, a newly devised procedure for low temperature brazing by means of induction heating coils contributes in no small degree to the quantity production of explosive missiles for Tokio and Berlin.

The brazing is done in order to weld ¾ in. threaded flanges into completely closed 20 gauge sheet steel containers. A low temperature brazing alloy containing 50% silver is used; this alloy has a melting point of 1,175 F. A low temperature brazing flux, which starts dissolving oxides at 800 F and is completely liquid at 1,100 F, paves the way for the uninterrupted flow of brazing alloy throughout the entire joint area.

The flange is cleaned in a degreasing compound and is then fluxed on a motor-driven spindle. The operator doing this work simply dips a brush in the flux jar and holds it for a few seconds against the revolving flange. The container—after a thorough cleaning with a wire brush set in an electric drill—is also fluxed.

Next the flange and a prefabricated ring of $\frac{1}{16}$ in. brazing wire are pressed into position by hand. This operation is shown in Fig. 1. The traveling carriage holds three sheet steel bomb containers and rides the production line on an angle-iron rail. It is these and similar methods of fast handling which render it possible to maintain the production rate of 2,400 brazed bombs per day.

Fig. 2 shows the manner in which the heating coils are placed over the flanges. The coils are energized by an induction generator and rapidly heat the flanges and a small area of each steel container. The flow point of 1,175 F is reached in such fast time that the braze is completed within 35 seconds. Then the heat is automatically shut off, and air jets solidify the brazing alloy.

The excess flux and oxides are removed in a sand blasting machine having a capacity of three bombs every 20 seconds. During this operation, the bombs are in a horizontal position so that the blast is directed only at the tail end of each bomb.

The final step is to test for "leakers." This is done by subjecting the containers to an air pressure of 65 psi for a timed period of one minute. The occasional rejects are quickly and inexpensively rebrazed on the production line.

* * *

Acknowledgment is made to Handy & Harman, New York City, for permission to reproduce the accompanying photographs.

Fig. 2—The induction heating coils are energized by pressing a button. A pilot light signals the operator when the braze has been completed, and the heat shuts off automatically.

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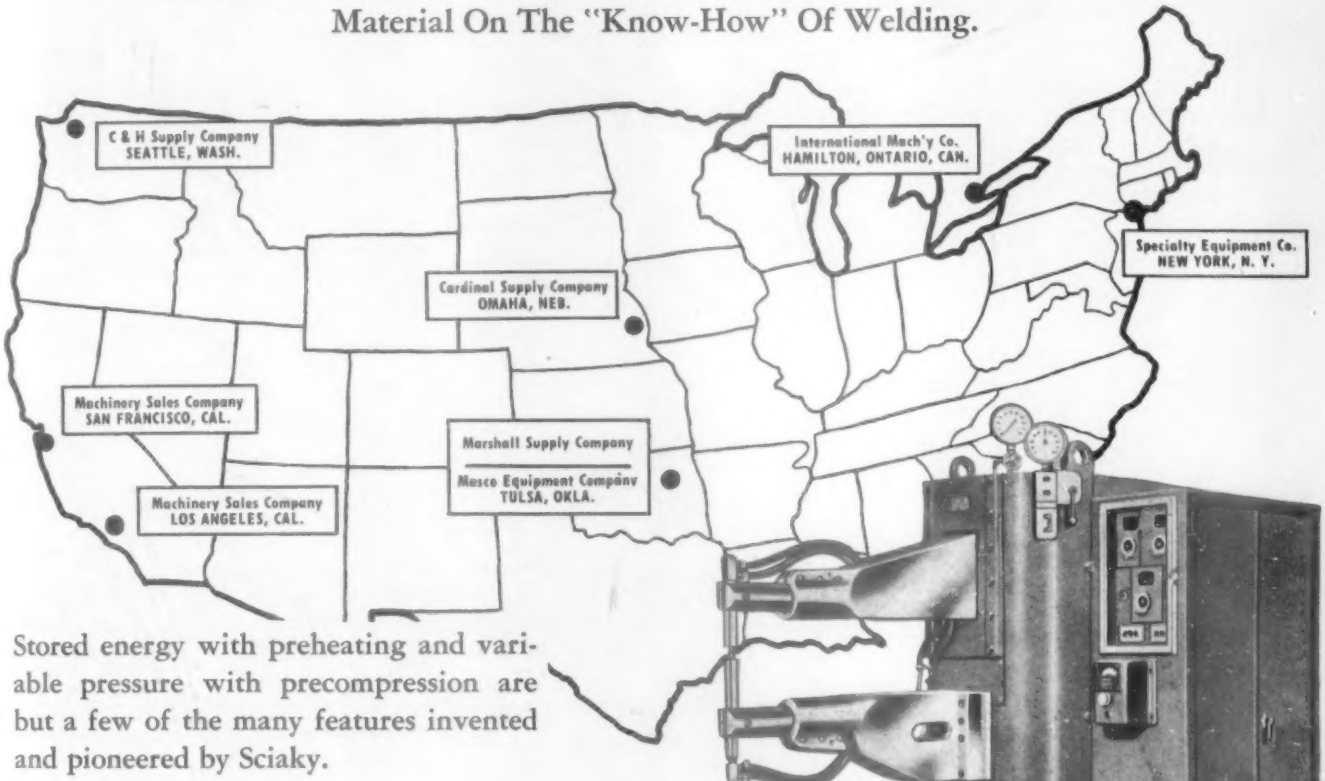

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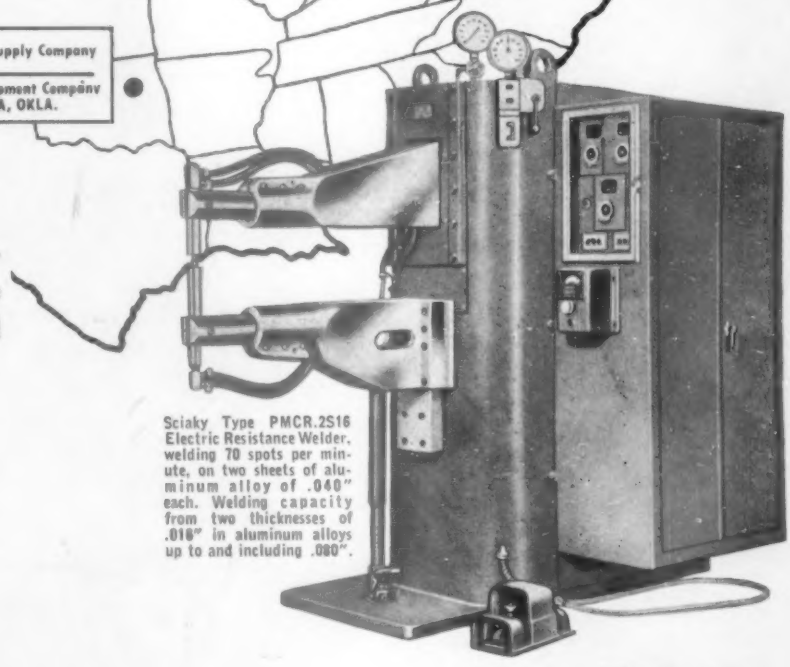

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Let Us Not Go Backwards!

By **C. J. HOLSLAG**
Electric Arc, Inc.

Are weldors spending too much of their time in needless chipping and hammering operations? This authority holds that useless picking at slag is slowing our War Effort.

THE TREND of certain Government inspection departments and certain insurance inspectors is putting us back to where we started in the last war. During World War I, the use of heavy covered electrodes had to be abandoned because more time was spent in chipping than in welding. We now seem to be getting back to about the same state.

Where Chipping Is Necessary

Of course, chipping is good on pipe work where there can be no other inspection. Here the chipping must be done in order to see if the weld is perfect before proceding with the next layer. In some cases, the molecular structure is bettered by hammering and caulking, especially with a pneumatic tool. This is an old boilermakers' trick; it permits the welding of cracks or of some closed member of which welding would otherwise be impossible.

Caulking and peening are also used to correct and control dimensions and fits. The natural contraction of the weld metal can be neutralized by hammering out the welded deposit to occupy the desired space. These are legitimate uses of chipping and hammering and cannot be discarded.

At one time, Navy specifications stated that no electrode producing a slag which had to be chipped or hammered off would be considered. Then I gloated in the triumph of electrodes with coverings so friable that no chipping was necessary or, at the most, it was only necessary to rub the bead with the bare end of the next electrode to clear the path for the succeeding layer. Has the manufacture of such coated electrodes been abandoned? Not in the least!

Slag Picking Wastes Time

With practically all of the covered electrodes made at present, there is no need for chipping. On most work, especially fillet welding, almost any modern electrode will permit two, three, four or five layers to be laid down without stopping for any chipping whatsoever. The great wave of chipping and picking which has suddenly become fashionable is slowing up the War Effort, in my own opinion and experience.

Furthermore, a very great advantage can be gained where there is a shortage of covered electrodes by using a lightly coated electrode for every other layer; instead of chipping off the slag produced by a heavy coated electrode, use it as a covering for the next layer, that is, the layer deposited by a lightly coated electrode. This will do two things: dilute the covering to about the right thickness and allow 30% more electrodes to be used than our extruding machines can produce at the present time.

The old-fashioned coated electrodes had such a thick and tenacious covering that the resulting slag had to be chipped off. Not only was it necessary to chip off the slag between the layers, but you had to chip it off whenever you broke the arc and started again. The glasslike covering of these old electrodes was absolutely insulating, and a very careful procedure had to be used to keep the slag from getting around in front of the arc and putting it out.

Glasslike Electrodes Out

The glasslike flux type of electrode is no longer manufactured. Modern friable coated electrodes are not only much easier to run, but they do not have to be chipped. If there is any electrode manufacturer who claims his covering should be chipped, he should be referred to the accompanying list of the properties and possible functions of welding rod ingredients. By using the correct amounts of these materials and mixing properly, an electrode covering can be made which will either break itself off when cool or come off with a slight rub from the next electrode.

Electrode Coating Ingredients and Their Functions

INGREDIENT	FUNCTION
Alpha cellulose (See also carbonaceous material, cotton and rayon, paper, paper pulp, wood flour)	To form carbon oxides during burning, thus consuming oxygen which is kept away from the weld metal. The gases formed also "blanket" the fused weld metal. Before burning, it provides support for the coating. Final contribution is to the formation of a shield during welding.
Aluminum monohydroxide (diaspore)	To impart friability and ease of removal of a slag in which titanium dioxide and sodium silicate have also entered. Also to control the melting point and consistency of the slag.
Aluminum oxide (alumina)	
Aluminum-bearing silicates	
Asbestine (magnesium silicate)	To insulate and protect the weld by supplying magnesium silicate to act as a carrier or dilutent for titanium dioxide, contributing to removability of the slag. Asbestos and asbestine strengthen the coating.
Barium carbonate	On decomposition at the welding temperature, to furnish carbon dioxide for protection against oxidation and to impart brittleness to the slag.
Borax	To function as an adhesive where a ceramic coating is applied to the rod.
Calcium carbonate	To furnish carbon dioxide to blanket the weld and to impart desirable properties to the slag in order to improve the penetrating properties of the arc.
Calcium chloride	To dilute elemental titanium and to increase speed of welding.
Calcium fluoride	
Calcium hydroxide	To serve as a lubricant in the drawing operation for application of the coating by extrusion.
Calcium molybdate	To transfer molybdenum from the coating to the fused metal, in cases where this element is needed in definite proportion in the finished weld.
Calcium oxide (lime)	To adjust basicity of slag, usually along with silica, and to serve as a dilutent.

Electrode Coating Ingredients and Their Functions

INGREDIENT	FUNCTION
Calcium silicates (usually introduced as part of complex silicates)	To regulate such properties of the slag as melting point, consistency, friability, etc., especially where the silicate contains appreciable aluminum.
Carbon Carbonaceous material	(1) As an alloying element to be transferred from coating to weld metal. (2) To burn to form carbon oxides to blanket the weld and deoxidize. Used in wrappings either around an inner mineral coating, as an inner coating with mineral binder, or as an inner wrapper impregnated with mineral coating to perform the above mentioned deoxidizing function and/or strengthen the coating; often to form a shield.
Cellulosic material	See above under carbonaceous material.
Cerium	Deoxidizer.
Clay	To furnish silicates for the slag and in some cases to dilute elemental titanium where used as ferro-titanium or manganese titanium. As fire clay, to provide insulation and regulate boiling point of slag.
Clay, silicious and titaniferous	To form slag and at same time furnish titanium and manganese.
China clay	To raise melting point of slag when used in conjunction with silica, titanium compounds and other clays under restricted limits.
Cotton and rayon	Utilized as fibers for wrapper as described under carbonaceous material.
Chromium	To transfer chromium from coating to weld metal; in early usage believed to be a deoxidizer.
Coal, high volatile	See carbonaceous material.
Dead burned slag	To quiet the reaction and dilute the flux dry.
Ethyl orthosilicate	Binder.
Feldspar	To provide silica content of slag; to contribute to arc stabilization.
Ferro-chrome Ferro-chromium	To transfer chromium from coating to weld metal during welding, minimizing oxidation; to deoxidize.
Ferro-manganese	To transfer manganese from coating to weld metal during welding, minimizing oxidation.
Ferro-titanium Ferro-carbon-titanium	To deoxidize and denitrogenize during welding, minimizing formation of oxides of iron, manganese, etc., and nitrides of iron in and adjacent to the weld, finally entering slag for protection.
Gum Arabic and other water soluble gums	Binder and dispersing agent; this material also furnishes carbon oxides on burning (see carbonaceous material).
Ilmenite or titaniferous iron	To supply oxydic compound of titanium and contribute to the formation of a suitable slag (See titanium dioxide).
Iron ore	In conjunction with ilmenite, to adjust the titanium content and also the manganese content.
Iron oxide	Used in certain proportions with titanium dioxide, silica, and silicates, iron oxide is said to contribute to arc stability.
Kaolin (See clay)	
Magnesium carbonate (as such or when present in silicates)	To provide carbon oxides to blanket weld and to form slag.
Magnesium oxide	To adjust basicity and other properties of slag.
Magnesium silicates	See asbestine, asbestos, etc.
Manganese carbonate	To provide a reducible compound of
Manganese dioxide	manganese, usually along with elemental manganese alloy, or silicon alloy,
Manganese ore (pyrolusite)	etc.; to transfer unoxidized manganese from the coating to the weld.
Manganese-titanium	Deoxidizer—denitrogenizer. (See ferro-titanium).
Mica (pyrophyllite)	See aluminum-bearing silicates.
Molybdenum and compounds	Introduced usually as a molybdate for alloying (see calcium molybdate).
Organic material	See carbonaceous material.
Paper, paper pulp-fibrous	See carbonaceous material.
Potassium feldspar	See feldspar.
Potassium silicate	Binder and source of potassium and silicate for the slag.
Rutile and rutile-bearing minerals	To furnish a titanium dioxide.
Silica Silica flour, amorphous silica, etc.	To form slag, regulate its consistency and melting point and contribute to protection of weld and quality of the arc. Such functions may result from the reaction of SiO_2 with Na_2O, CaO, MgO when these are present as such or from decomposition of silicates or carbonates. Finely divided amorphous silica also provides bulk to obtain a satisfactory thickness of coating.
Silicates See asbestos, clay, magnesium silicate, talc, etc.	
Silico-manganese	To provide for the transfer of silicon and manganese from the coating to the weld.
Silicon esters	Binder.
Slag	Electric furnace or open hearth; dried and powdered as a dilutent and mechanical thickener and quieter.
Sodium carbonate	To provide carbon oxide gases. Primarily, to react with titanium dioxide to form sodium titanate and with silica to form sodium silicate.
Sodium silicate	Most widely used liquid binder for ingredients of coating—also contributes to formation of slag.
Sodium titanate	Former, or added as such carries titanium dioxide for arc stabilization, and into slag.
Talc (See asbestos, etc.)	
Titanium dioxide as such or from other compounds, titanium ores, etc.	To stabilize and steady the arc and contribute continuity, uniformity and impermeability to the slag, thus protecting the weld metal from reaction with the contact atmosphere. To deoxidize and denitrogenize the weld metal and surrounding contact atmosphere. To reduce the voltage required and speed up the welding process.
Tungsten	Alloying element.
Uranium	Alloying element.
Vanadium	Alloying element.
Water	To dissolve and dilute sodium silicate or other binders and to regulate consistency of coating mix during application.
Wood flour Wood pulp, etc.	See carbonaceous material.
Zirconia or Zirconia ore	In conjunction with oxydic compound of titanium, to impart desirable properties to the slag.

On the Job

Welded Motor Frames

By **R. I. HANFORD**

Ilg Electric Ventilating Co.

CASTINGS of mild steel were being used for D-C motor frames because of the ability of this material to be worked at a much higher density than iron for a given number of ampere turns. Hard spots in these casings, however, slowed up machining considerably, and the presence of blow and shrink holes, accompanied by surrounding hard surfaces, tended to create an unbalanced distribution of flux passage to the various field poles.

Radiograph of welded D-C motor frame. The dark circular spots indicate the pole piece holding screw holes, and the lighter part of the picture at the bottom indicates a much thicker section than the darker area. The weld is so homogeneous with the rest of the metal that it did not leave traces.

To offset these disadvantages, it was decided to replace cast steel with rolled steel fabricated by welding. This latter-type frame was made from a steel billet rolled into a ring. The ends were butt welded together, and a heat treatment was given to relieve the frame of any stresses or strains.

The external appearance of the weld was so good that it was not discernible after machining. Hence, it was decided to X-ray some of the frames in order to make sure that a homogeneous weld was being made, without slag, oxide or flux inclusions. The size of the frames thus tested was 16½ in. OD, 8¼ in. wide. Four radiographs of each frame were taken, each radiograph embodying one-fourth of the circumference.

The results of the tests were highly satisfying as is shown from the radiograph reproduced here. The welded section proved to be so similar to other parts of the frame that no evidence of the weld could be found.

» «

High Frequency Brazing

A CERTAIN brazing operation on parts for war goods being produced at a General Electric plant had been performed with torches. Because a high quality joint was needed, only highly skilled workers could be used, of whom there were not enough. The decision was reached to try doing the brazing with high frequency induction heat. This cut the time required for the operation from 4 minutes to 40 seconds.

"Previously, great care had to be taken not only during the operation but also in its inspection," explained J. P. Jordan of the G-E Radio, Television and Electronics Dept. "Now women operators are used, uniform joints are achieved, and the need for inspection is eliminated."

Flywheel Repaired

LITTLE known is the work of the maintenance men in steel plants—the men behind the men who are breaking all records for steel output. A typical example of problems encountered by steel plant maintenance men was the repair of a half ton cast iron flywheel at the Inland Steel Co., Indiana Harbor, Ind.

The wheel, an urgently needed special job, had been dropped during shipment and broken. It would have taken months to get a new one. Maintenance men, however, prepared the wheel and spoke for welded repair. The breaks were easily welded with cast iron electrodes, and the flywheel was ready for use four hours after the break was discovered.

A new wheel, incidentally, would have cost $1,000 but the welded repair, including finishing time, was only $4.90.

Courtesy, Hobart Bros. Co.

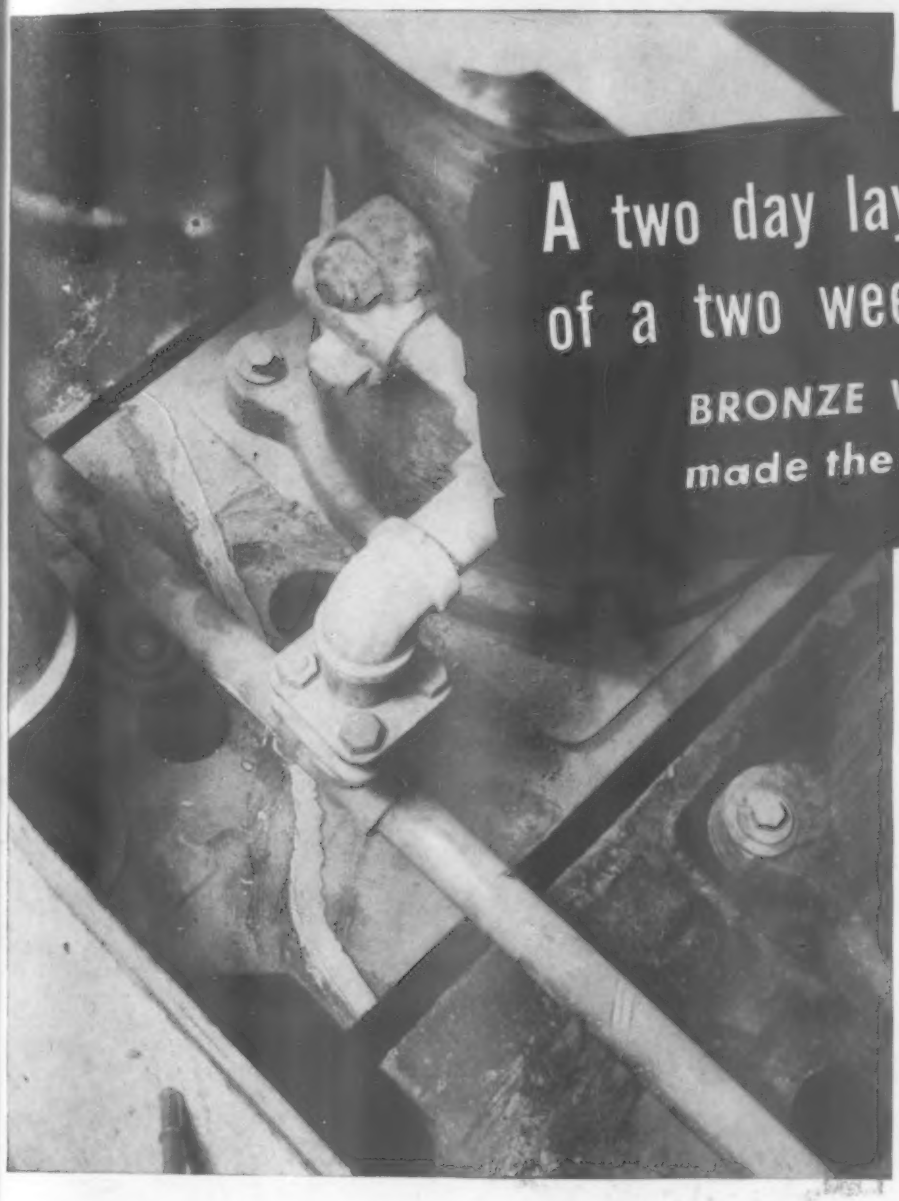
Broken during shipment, this ½ ton cast iron flywheel was repaired by welding with cast iron electrodes.

Courtesy, Westinghouse Electric & Mfg. Co.

Resembling a giant cheese in appearance, this 70-ton flywheel was fabricated by welding five thick steel plates together. The wheel will go into a 6,000 kw motor generator set to provide direct current to power mills rolling steel for war uses. It is 20 in. thick, 15 ft. in diam. and will make 357 rpm—equivalent to a speed of 192 miles per hour if it were to be rolling along a highway.

Courtesy, The Linde Air Products Co.

Round and square steel bars are cut into forging blanks for shells by these speedy oxy-acetylene cutting machines. The cutting is continuous from one side of the bed to the other across the entire row. While a bar is being cut, the starting edge of the adjacent billet is being preheated with a manually operated torch. Square bars are cut into 6 in. lengths, round bars into 24 in. lengths.



A two day lay-up instead of a two week delay . . .

BRONZE WELDING made the difference

This bronze repair weld on a 2½-ton bolster has no trouble standing up under 2,000 pounds per square inch hydraulic pressure. Picture from The B. F. Goodrich Company.

When this 2½-ton bolster on a belt packing press cracked in a B. F. Goodrich plant, the press was "down", and vital war production had to wait. But as has happened so often in industry, bronze repair welding cut the time loss to the bone . . . in this case to two days. It would have taken two weeks to get a new casting.

After 32 hours of work and the use of 125 pounds of Tobin Bronze* Welding Rod, the press was back at work . . . the repair weld successfully withstanding the 2,000 pounds per square inch pressure exerted hydraulically on the bolster.

For speedy, wartime emergency repair welding, you just can't beat Anaconda bronze. Anaconda 997 Low-Fuming and Tobin Bronze, among others, meet every requirement for efficient, durable repair welding. For complete information, write for the new edition of Anaconda Publication B-13. 4888

*Reg. U. S. Pat. Off.

ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

Subsidiary of Anaconda Copper Mining Company • In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

New Products to Use

Half-Cycle Welder Control

★ A half-cycle synchronous electronic control for small-sized resistance welding machines is announced by the **General Electric Co.** It features a new tube, the GL-415, a new circuit said to make higher welding speeds possible and a simplified initiating circuit. Heat control is here accomplished by the phase-shift method, the heat adjustment being made by a dial on the front of the cabinet.

This new control is stated to facilitate: the welding of tinned copper, steel or alloy wires; of 0.01 to 0.05 in. diam. studs to flat surfaces; the spot welding of unsually thin (less than 0.01 in.) pieces of mild steel, stainless steel, nickel or silver to brass or bronze; and the welding of low resistance joints to replace soldered joints. The last-mentioned application, manufacturer asserts, will save tin by the elimination of solder.

One of the new G-E half-cycle electronic controls with a "phantom" bench welder attached.

Mounted in a protecting cabinet, the control is furnished in two types: the CR7503-A136, which includes a welding transformer and is designed for bench mounting, and the CR7503-A133, which is without a transformer and is designed for wall mounting. Both types can be used either with tongs or with a suitable bench welder. The CR7503-A136 is the control illustrated.

» «

Weld Cleaning Tool

★ The use of tools specially engineered for weld cleaning is a valuable help in speeding up welding operations, particularly where huge welding crews, such as are so often found on today's wartime jobs, are involved. In this connection, a new combination **"Dual-Tool"** for weld cleaning has just been announced by the **Atlas Welding Accessories Co.**, 307 Boulevard Bldg., Detroit.

This device includes both a replaceable brush and an interchangeable chipping head in which either a sharp-pointed or chisel-pointed chipper may be used. This tool features a new "Grip-Tite" brush holder which makes the operation of reversing or replacing the wire bristle brush a matter of seconds. The chipping head is replaceable by removing the single pin which holds the head in place on the shaft.

Atlas Dual-Tool, Model "A" for heavy duty. Either a sharp-pointed or chisel-pointed chipper may be used with the wire bristle brush.

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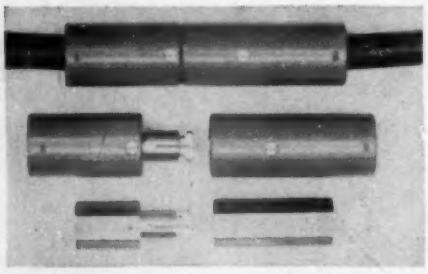


"Sol-Con" cable connector. Made in two models: No. 1 for Nos. 4, 2, 1 cable; No. 2 for 1/0 through 4/0 cable.

Cable Connectors

★ The Tweco **"Sol-Con"** is a detachable-type cable connector that may be quickly disconnected by a turn and toggle of its two ends, a male plug and female receptacle. The bore of the receptacle is broken by a ⅛ in. pin key. After the flatted end of the male plug has passed the pin key, a slight turn will lock the key securely in the plug's ring groove. Then the connector will come apart at only one point—where the screws in the red fibre covers line up, as shown by the accompanying illustration.

Tweco Products Co., English at Ida, Wichita, Kansas.

Arc Welding Control

★ A new type of arc welding control, the **"Lincontrol,"** is strapped onto the weldor's foot. It weighs little more than a shoe, enabling the wearer to move about freely. The arc may be adjusted from wherever the operator happens to be since he does not have to keep his foot in any certain place, as is necessary for the ordinary stationary foot control.

Arc welder foot control. It is worn like a shoe, enabling the operator to move freely from place to place while retaining control over the welding arc.

This control was especially intended for aircraft welding, but it is applicable to welding of light gauge sheet metal of all kinds. To increase current, the weldor merely exerts pressure on the pedal. By this means, he can achieve an accurate control over the welding arc, effecting substantially the same results, according to this manufacturer, as are given by the use of "hot-start" and crater eliminator devices.

The control is designed for Lincoln "Shield-Arc Junior" welders, which can readily be adapted for it through installation of a new voltage rheostat. The **Lincoln Electric Co.**, Cleveland.

» «

Bulletin Board

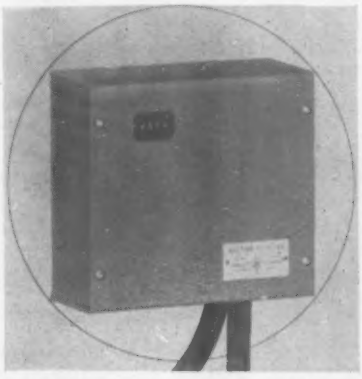
★ An illuminated bulletin display cabinet known as the M.S.A. **"Tell-Board"** is offered for the better display of safety and morale posters, instructions or special messages. The glass front is swung on a pivot joint at the top, permitting quick removal and replacement of the fibre board on which the bulletins are posted. The posters and bulletins are illuminated by two incandescent lamps mounted inside the top of the cabinet.

The cabinet is constructed of noncritical materials—white pine, Masonite and glass—and is finished in two-tone green enamel. Removable fibre board is 24 by 27 in. An inside depth of 2 in. provides some space for equipment display.

Mine Safety Appliances Co., Braddock, Thomas and Meade Streets, Pittsburgh.

Welding Time Recorder

★ The new **"Arc-Time Totalizer"** is said to be useful in providing accurate data for production control, better utilization of equipment or bonus payments to weldors. This instrument gives an accurate, inexpensive check on production by recording the cumulative time that actual welding is being done. The time is recorded in tenths of hours on a scale which will give a reading up to 9,999.9 hr.



Arc-Time Totalizer. It may be readily attached to an arc welding machine and will record the cumulative time that actual welding is being done.

The instrument is mounted in a compact steel box which can be attached to welding motor-generator sets. There are two models available: Model 1001A, which registers the total welding time only, and Model 1010A, which is equipped with an automatic starter for the generator. The latter is said to be particularly useful when intermittent welding is being done or when only one or two weldors are working from a single generator set. **Hewlett-Packard Co.**, 395 Page Mill Road, Palo Alto, Calif.

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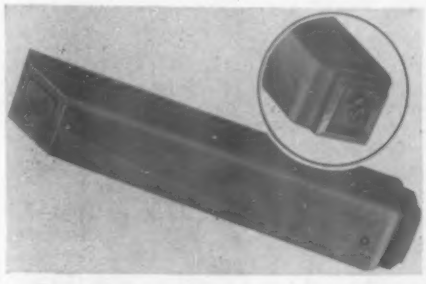

Peg and pin etching stamp. A popular style, used where large volume inspection and product stamping is required.

Etching Stamp

★ A line of stamps suitable for the marking of metal parts is announced by **Jas. H. Matthews & Co.**, 3942 Forbes St., Pittsburgh. These new stamps are made of a recently developed synthetic material, said to be unaffected by acid etching inks and to have three or four times the life of rubber stamps. Inks are available for etching plain carbon steel, iron, aluminum, copper, zinc, brass, high-speed or alloy steels and blued steel.

Reclaim Worn Parts by METALLIZING with a Mogul Gun

New Service Opportunities By Installing Metallizing Equipment Now

SPRAYED ZINC protects surfaces from corrosion. This is an important application of the metallizing process. Above, a MOGUL gun in action for spraying zinc on railroad bridge.

EQUIPMENT REQUIRED FOR METALLIZING SET-UP
1. Air control unit. 2. Oxygen tank. 3. Acetylene tank. 4. Oxygen pressure regulator. 5. Gas pressure regulator. 6. MOGUL metallizing gun. 7. Wire reel stand. 8. Air, oxygen and gas hoses. 9. MOGUL Operating Manual. 10. Wooden carrying case for MOGUL gun.

MOGUL metallizing guns are proving indispensable to the war effort in rebuilding worn parts of all kinds. Alert welding shops are installing this equipment not only to meet today's demand, but also to prepare for the post-war business. As welding became a major industry in the last war, metallizing is fast becoming vital on all maintenance jobs today.

MOGUL
PIONEER IN METALLIZING

Over 20 years of experience has been built into the MOGUL Model P gun. It is ruggedly constructed with simplified design—a combination that will insure years of trouble-free operation. No previous metallizing experience is necessary to operate a MOGUL gun, with which you can spray practically any metal. MOGUL is designed for use with acetylene, propane, butane, or generated gas.

Investigate the opportunities in this field today. Write for catalog showing money-saving applications as well as a full description and prices of MOGUL guns and equipment.

METALLIZING
COMPANY OF AMERICA
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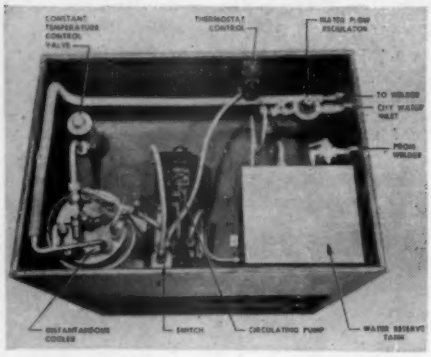
Cooler for Spot Welders

★ Temprite Model 580-C is a self-contained cooling unit designed to supply a constant flow of low temperature water (40 F is stated to be the ideal coolant temperature) to spot welder tips and transformers. Such cooling, states manufacturer, "is of particular importance on aluminum spot welders where the peculiar structure of the metal requires that the welder tips be maintained at a constant controlled low temperature at all times."

The cooler is equipped with a temperature control valve, a 1 hp refrigeration condensing unit and a ½ hp water circulating pump. The unit can be used to serve one, two or three spot welders, depending on the maximum heat load and the resistance to flow through the welder water circuit. Maximum capacity varies from 86 to 152 gallons of water per hr, depending on temperature rise of the cooling liquid. The system is capable of circulating 120 gph against a spot welder pressure drop of 100 lb gauge. Pump is equipped with an adjustable by-pass valve so that the rate of water flow through the spot welder assembly can be controlled.

Temprite Products Corp., 47 Piquette Ave., Detroit.



Spot welder cooler. It is said to give longer life to electrode tips.

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Metal Spraying Unit

★ **Metallizing Engineering Co., Inc.**, Long Island City, New York, announces equipment for its new "fuse-bond" process of preparing metal parts for metallizing (metal spraying). By this method, an adequate bond for metallizing may be obtained on hard surfaces that were heretofore impossible or impractical to prepare by blasting or rough threading. The new process also simplifies the preparation of narrow edges, flat areas, and cylindrical parts having keyways or other interruptions to their surfaces.

"Fuse-Bond" Type C unit for preparation of surfaces to be metal-sprayed.

The Metco "fuse-bond" unit, Type C, shown in the illustration, operates on single-phase current, either 110 or 220 volts. Its purpose is to fuse a rough deposit of electrode metal onto the surface to be metallized. Electrodes are applied to the work with a special holder which handles up to six electrodes at one time. With this equipment, small parts may be prepared for metallizing as easily as large shafts since there is no excessive heating of the base metal or disturbance of its physical characteristics.

The unit is portable and is contained complete in a castor-mounted cabinet measuring 24 in. high. Cables and attachments fit into a bin in the top of the cabinet.

YOU TELL 'EM MR. HOLLEY
HOLLEY WELDING CO
The Governor gives a current value which is as "stable" as an electric motor drive—or better!
What YOU Think of PIERCE GOVERNORS

This Pierce Flyball Governor on Mr. Holley's outfit is the key to perfect welding

So says C. W. Holley, of the Holley Welding Company, Burbank, California . . . And Mr. Holley goes on to say that "the above statement is attested to by several aircraft production welders who have tested it in close, fine kinds of work."

Opinions of expert welders are unvarying that Pierce Governors give close, sensitive regulation. Their action is positive and reliable at all times. They assure fast recovery of current characteristics after striking arc for good, strong welds. And, they are built to give years of trouble-free service.

Now and after the war, insist on Pierce Flyball Governors to regulate your welding operations.

HOW TO MAKE YOUR GOVERNORS LAST!

Like others manufacturing for war needs, Pierce production is for war and essential industry. For this reason new governors can be supplied only on a priority basis. But Pierce calls attention to these easy measures which will make your present Pierce Governors last and give the best service.

- **CLEAN GOVERNORS** once a month with kerosene, gasoline, or prepared cleaner.
- **INSPECT AND CHECK GOVERNORS** each week when in continuous operation.
- **CHECK OIL LEVEL** every day in manually lubricated governors. SAE 20 is recommended at this time of year.
- **LINE UP** driving pulleys or gears accurately when reassembling governor after cleaning.

THE PIERCE GOVERNOR COMPANY
1607 OHIO AVENUE • ANDERSON, INDIANA

Pierce Governors
STANDARD SINCE 1913

The NEW G-R 45 MEETS WAR DEMAND FOR WELDING TOUGH ALLOYS

... with advantages of A-C Transformer-Type Welding

ARMOR-PLATE and tough alloys present special welding problems. G-R has met the demand fully with this new heavy-duty A. C. manual welder incorporating new characteristics.

Heat control is infinitely variable throughout an extreme range...from 20 to 625 amperes! Efficiency is high, power factor correction standard. G-R 45 handles heavy war work with ease, yet may be adapted instantly to the fabrication of light metals . . . an important advantage when peace brings the changeover to consumer products.

Talk with your nearest G-R Distributor or write, wire or telephone

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(Trade Mark Registered)

Doubly-Deoxidized Welding Alloys:

PENN BRONZE

TITAN BRONZE

TITAN MANGANESE BRONZE

Specify Titan Welding Alloys

TO ASSURE UNIFORMLY SOUND, STRONG, DUCTILE BRONZE WELDS

Doubly-Deoxidized PENN BRONZE, TITAN BRONZE and TITAN MANGANESE BRONZE Welding Rods have proved their definitely superior welding qualities over a period of many years and under the most exacting requirements.

The Double-Deoxidization process, developed by Titan engineers, definitely increases the ductility of the weld metal, reduces fuming to a minimum and assures a sound, dense, strong weld.

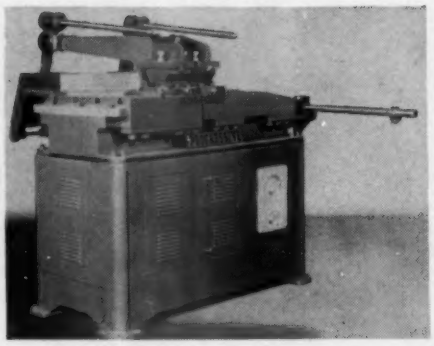
Descriptive literature sent upon request

TITAN METAL MANUFACTURING CO., BELLEFONTE, PA.

TITAN WELDING RODS

Flash Welders

★ **Progressive Welder Co.**, Detroit, announces production of the first model in a new series of standardized flash welders. The new model "C" is rated at 150 kva and incorporates an electronic "Flash-trol" monitor said to provide automatic control of weld quality by eliminating short-circuiting of the flash welding arc. This device, it is stated, makes possible a higher than normal rate of acceleration of the feed platen while performing the weld, thus insuring the maximum rate of weld completion without danger of any incomplete welds or line overloads due to short-circuiting.



Progressive Model C-150 flash welder. These are available for both automatic and for conventional manual operation as shown here.

In flash welding, a maximum speed and force of upset is desirable. Upsetting speed and pressure are obtained on the new Progressive model through the use of an air hydraulic booster, which forces oil in the proper quantity at high speed into the platen traversing cylinder. The air cylinder is actuated by a relay that is tripped by the platen when the "upset" position is reached.

The platen feed pump is driven by a D-C shunt motor powered through grid-controlled rectifiers from a single-phase A-C line. The feed is preset to an acceleration of platen travel somewhat faster than normal average for the pieces being welded. The actual rate of platen feed is then monitored by the amount the platen has traveled from its starting position, this being accomplished by means of a newly developed rectifier control.

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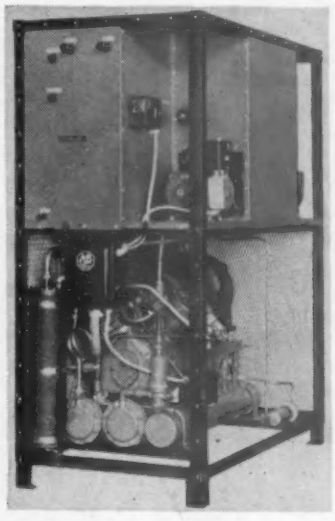


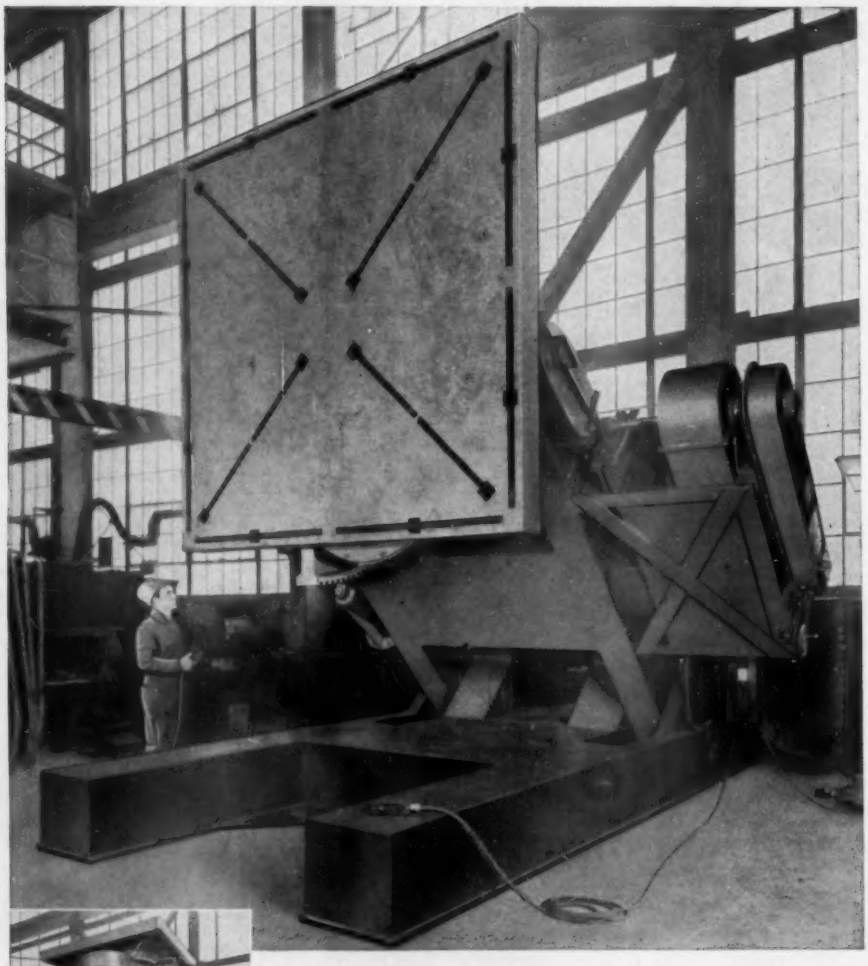
Cooling unit for spot welder tips. It can be operated simply by connecting condenser water lines and electrical circuit.

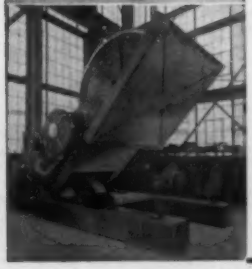
Spot Welding Tip Cooler

★ **Fairbanks, Morse & Co.**, 600 S. Michigan Ave., Chicago, announces a self-contained cooling apparatus for circulating a liquid coolant through the electrode tips of a spot welder. Claim is made that the **F-M Spot Welding Tip Cooler** has made it possible for aircraft plants to increase by as much as 1,400% the number of aluminum spot welds that can be made between tip cleanings.

Operating fundamentally as a refrigerating machine, the unit is equipped with two motor-driven pumps and a thermostatically controlled 4-cylinder compressor. A recirculating pump, operating continuously with the compressor, circulates Freon-12 refrigerant through the evaporator for high heat transfer, while a turbine-type pump circulates a special non-corrosive, non-precipitating solution of high specific heat characteristics to the welding tips and back again.

The cooling unit stands 55 in. high and occupies a floor space of 25 by 44 in. It is designed to cool the tips of one spot welder only.





Today's specifications read . . .

"MUST BE POSITION WELDED"

To guarantee flawless welds, stronger unions and smoother, cleaner fillets, buyers of welded products today specify, "must be position welded."

The greatest advance in welding technique, position welding, not only assures a better product but reduces spoilage and rejects, cuts actual welding time by permitting the use of larger rods, and cuts crane, crane crew and welders handling and set-up time to a fraction. *On a C-F Positioner weldments and assemblies can be welded down-hand on ALL sides with a single set-up;* can be revolved completely around and tilted to any point up to 135° from horizontal. C-F Positioners come in capacities from small hand operated positioners to large variable speed giants that twist and turn 30,000 lb. weldments under push control.

Write for Bulletin WP 22

CULLEN-FRIESTEDT CO.

1309 S. Kilbourn Ave. Chicago, Illinois

Do You Agree?

This new department of THE WELDING ENGINEER will provide the reader with answers to questions of general interest. Selected queries received each month by the editor of THE WELDING ENGINEER will be answered on these pages. If you, as a reader, do not agree with our answers, let us know. Your comments and discussions will be published, too.

Thawing Frozen Pipes

Question: I have heard of weldors using their portable gas engine machines to thaw frozen water pipes. How is this done?—*E. M.*

Answer: The thawing of water pipes with an arc welding generator is a relatively simple job. The leads from the generator are connected to the pipe or piping system so as to include the frozen section in the electric circuit. The current warms the pipe; very shortly the ice is softened, and water begins to flow.

The amperages required and the time necessary to effect thawing will depend on the size and length of the pipe. For example, according to the experience of some users, 250 amp will thaw a ¾ in. pipe, 300 ft long, in from 3 to 10 min. On the other hand, a 3 in. pipe, 100 ft long, will take nearly an hour and require current in the neighborhood of 500 amp. The voltage involved varies widely, but usually between 10 and 50 volts are required.

Copper and brass pipes conduct current much more readily than iron or steel piping and consequently take a higher current and a longer time.

When the current is turned on, care must be taken to see that no overheating occurs. This necessitates continual checking of the current at the joints. It is also important to avoid an overload on either the welding machine or the cables.

» «

Spot Welding Stainless

Question: Why is it that stainless steel is frequently referred to as "an ideal material for spot welding"? What type is preferred?—*H. M. P.*

Answer: Stainless steel is, in every respect, the ideal spot welding material because of its bright surface, its normally high electric resistance and its low heat conducting characteristics. Since stainless steel is normally bright and clean with high electrical resistance, the variables of the total resistance are reduced to a minimum.

The use of a full hard temper stainless steel will insure a maximum strength weld structure with the minimum of weight. The time of fusion during the spot welding of this material is so slight that there is little danger of affecting the strength of the material or of inter-granular corrosion.

OVER-HEAD WELDS

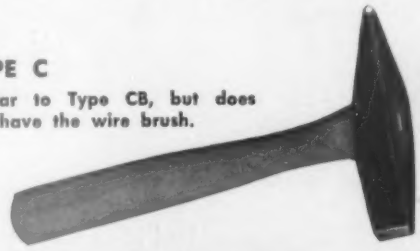
Especially
CALL FOR
CMD
CHIPPING HAMMERS

TYPE CB
Three Tools In One—Chisel, Drift and Brush.

In cleaning *over-head* or *vertical welds*, you will especially appreciate the light weight and perfect balance of CMD Chipping Hammers. These carefully made hammers not only make your job easier, but they speed up removal of slag and spatter. Type CB, shown above, is really *three tools in one*—chisel, drift and brush. The wire brush can be replaced when worn. This hammer, weighing only 16 ounces, is ideal for over-head welds and for use in close quarters. It is the result of 17 years of CMD experience in making hammers and other supplies for welders.

NEW CIRCULAR
Illustrating the complete CMD line is now ready. Write for your FREE copy Now!

TYPE C
Similar to Type CB, but does not have the wire brush.



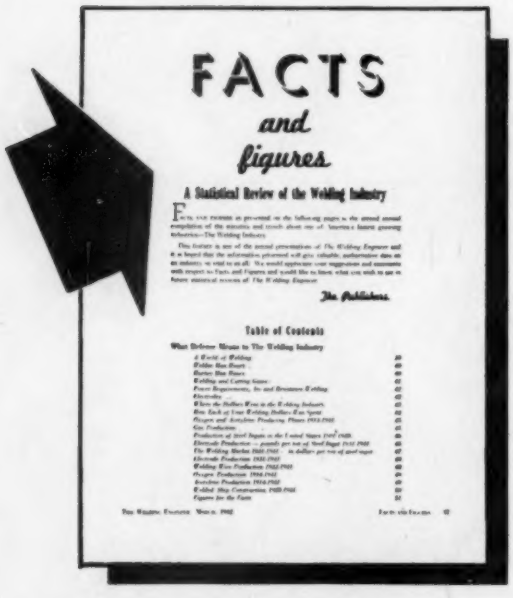
CHICAGO MANUFACTURING AND DISTRIBUTING COMPANY
Dept. W., 1928 West 46th St., Chicago, Illinois

The Welding Engineer's 1943 DIRECTORY AND STATISTICAL NUMBER

Coming In

March

Last Forms Close February 25th


FACTS
and
figures

A Statistical Review of the Welding Industry

Table of Contents

Everyone Wants to Know About the Industry's Statistics

A Directory Issue by itself makes an outstanding number. But The Welding Engineer's March Issue will have coupled with it the Annual Statistical Review of the welding industry—the only authenticated presentation of the industry's first full year of war. Here is one of The Welding Engineer's most popular features. Charts and graphs showing how the industry that readers are part of has fared are always eagerly studied. The Welding Engineer's statistics are widely accepted by previous presentation.

No Other Service Of Its Kind

There is only one directory containing information on all products used in welding, flame-cutting and allied processes. Compiling it requires checking and rechecking with all known manufacturers of welding equipment and supplies. The result is information on products, trade names and local sources of supply that can be found nowhere else in as complete and comprehensive form. This result is an opportunity for advertising you don't want to miss.

The Buying Guide for Highest Priority Orders

Welding needs get first choice today. It is the only process that is vital both to production and to maintenance and repair. Wartime industry needs instant knowledge of products and supplies, followed up by quickest call for service. Complete information on both little and well known products makes The Welding Engineer's Directory industry's buying guide for that purpose—a guarantee of enhanced value in all advertising as well.

Outstanding Advertising Opportunity of 1943

Air Corps Test

Question: What are the requirements for the Air Corps "B" welding test? One aircraft company gives one test and another will give another test, no two giving the same one, and still they call it the "B" test.—*M. O.*

Answer: The Army Air Force weldors' qualification which is given in accordance with Specification 20013-B indicates very definitely what test is required for qualification as a B class weldor.

The Air Corps tests are grouped according to metals, and each group involves four tests: the plate, the tube, the cross and the cluster. This test group is divided into A and B classes. The A class weldor is required to complete all four tests, while the B class is required to complete only the first two, which enables him to weld everything but primary and secondary strength structures. A weldor carrying a "B" certificate for a specified metal is not eligible to weld other metals or alloys unless he has been certified on them also.

The plate test requires that two pieces of 1/4 by 6 by 10 in. plate be welded together. Three standard tensile specimens are then taken, and these are pulled in a tensile machine. If an alloy base metal and a filler rod of 0.06% carbon are used, the specimen must withstand a tensile stress of 55,000 psi. The break is examined for good metal appearance.

The tube test determines the weldor's ability to weld tubular members in different positions. There are four specimens—two welded in a horizontal position and two welded overhead. The specimen must withstand a tensile stress of 80,000 psi when alloy base material is joined with a filler rod of 0.06% carbon.

» «

Hartford Certificate

Question: I recently graduated from a welding school and am seeking employment. Several of the shops at which I have applied have asked me if I have a Hartford certificate or if I have passed the Hartford test. What is the Hartford test, and how much does it cost?—*A. H. J.*

Answer: To have a Hartford certificate means that you are a weldor qualified under the Hartford Steam Boiler Inspection Rules and, because of your qualifications, authorized to weld on high pressure work; *i. e.*, work which comes under these regulations.

The Hartford test is primarily a procedure qualification test in which sample welds are made using the same plate, same equipment and same type of welding wire which are to be used on the boiler or job under construction. Even when this combination has been tested and approved, it is necessary before actual work can be started to satisfy the Hartford inspector that the welding operator who is to do the work is capable of producing welds equal in quality to those obtained in the procedure qualification test.

This qualification test remains valid for the individual weldor only so long as he continues to work in the same shop with the same equipment and the same welding wire. If the manufacturer should wish to change any of the details of his welding procedure, the weldor may be required to repeat the entire qualification program.

Though it is rather difficult to determine the cost of qualifying a weldor under the Hartford regulations, there have been instances where manufacturers have spent several hundred dollars in qualifying a single weldor.

» «

The difference between a cordial man and a grouch is good breeding. It takes a rather low degree of intelligence and no breeding to be a grouch. It takes intelligence, good breeding and eternal vigilance to be considerate and cordial.

CONVENIENT COUPON
CLIP AND MAIL FOR DETAILS of FRONT COVER
ATLAS AD

ATLAS
WELDING ACCESSORIES CO.
307 Boulevard Building
Detroit, Michigan

Rush details on complete line of Atlas Weld Cleaning Tools.

Name_____
Company_____
Address_____
City_____
State_____

Victory in Sight
DOCKSON
● Victory is won on production fronts too—Dockson Eye and Face protection is preventing costly injuries to workmen—workmen who must stay on the job if victory is to be ours.
DOCKSON CORPORATION
3834 Wabash Avenue
Detroit, Michigan

News of the Industry

Use of Alien Patents Offered Royalty-Free

About 50,000 patents owned by residents of enemy and enemy-occupied countries are now being offered on a royalty-free basis through the Office of Alien Property Custodian of the United States Government. The inventions covered by these patents represent research achievements of great potential value—both as means to facilitate the winning of the war and as contributions toward rebuilding our peacetime economy.

Where exclusive licenses are not already outstanding to American industry, the Office of Alien Property Custodian will issue non-exclusive, non-assignable licenses. A license application fee of $50 will be charged for each single patent, plus $5 for each additional related patent to be covered in the same license. The fees are payable at the time of filing the application but will be returned if the license, for some reason, should not be granted. These licenses are royalty-free and will be for the duration of the life of the patent.

A 26-page, 8¼ by 11 in. booklet, "Patents at Work," has been prepared by the Alien Property Custodian to outline its policies with regard to the administration of these patent holdings. This booklet gives full instructions for obtaining a license under a patent controlled by the Alien Property Custodian and includes an index to the classified lists of vested patents for use as a guide in ordering specific sections.

First step toward securing a license is to write to the Office of Alien Property Custodian, Chicago, for the lists of vested patents and patent applications cataloged under the class numbers selected. For "Metal Forging and Welding," the class number is 78, and the list which includes 64 patents and applications, may be secured for 10 cents.

Printed copies of vested patents and drawings and specifications of vested patent applications may be secured from the Commissioner of Patents, Washington, D. C., for 10 cents each.

» «

American Optical Celebrates 110 Years of Lens Grinding

American Optical Co., Southbridge, Mass., celebrated its 110th anniversary on Jan. 18 with the announcement that 1942 lens production was the greatest in company history.

Established in 1833 as a one-man concern, American Optical is the world's oldest and largest manufacturer of optical products. It now employs more than 12,000 men and women and operates three branch factories in the United States, two in Canada and one in England. More than 70% of the entire production is going directly and indirectly into the war effort.

» «

New Quarters for Harris

Harris Sales Co., formerly of Philadelphia, has moved to new and larger quarters at 88-90 E. Baltimore Ave., Lansdowne, Pa. The company has increased its manufacturing facilities and is now prepared to manufacture special types of welding and cutting torches and special cutting machines to customers' order.

(News continued on page 73)

DON'T SCRAP YOUR BROKEN HI-SPEED STEEL TOOLS!

"SUTTONIZING"

IS ON THE TOP!

"Suttonizing" has earned and is holding this "top spot" in the welding reclamation of hi-speed steel tools. Tough jobs have not slowed down "Suttonizing"—but rather have boosted its popularity unbelievably in the year that it has been used for salvaging most all types of difficult to repair tools. Wire or write for our catalog describing the "Suttonizing" method.

HERE ARE SOME TYPICAL TOOLS RECLAIMED BY "SUTTONIZING". Fractured teeth can be repaired on the following: shell mills • large size end mills • plain mills • broaches (subject to our approval) • side mills (cracked 4" O.D.—low limit) • boring, slotting, cut off and turning tools repaired or fabricated.

WELDING EQUIPMENT & SUPPLY CO.
221 LEIB STREET • DETROIT, MICHIGAN

Is the Steel Beam Strong Enough?

By W. F. SCHAPHORST, M. E.

IN THE event you have an unusually heavy load to lift and are contemplating the use of a steel beam, the accompanying nomograph will be found useful for determining the size of beam to use.

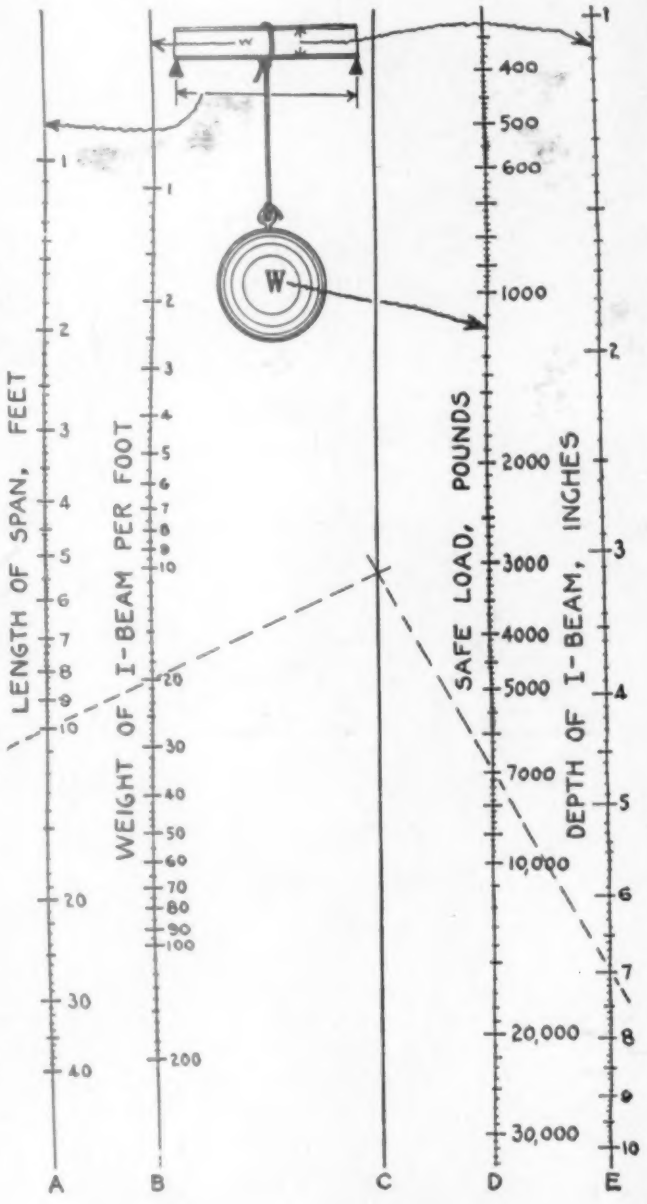
A concentrated load at the middle of the beam, as shown in the sketch in this nomograph chart, represents the worst possible condition—the condition requiring the largest beam for a given load. This chart is based upon such a load for the sake of safety. The wavy, narrow lines running from the sketch to the vertical chart lines give at a glance the purpose of each chart column. Column A indicates the length of span in feet. Column B is the weight per foot of the steel beam used. Column D is the safe load of the beam in pounds, while Column E indicates the depth of beam in inches.

Problem: Will a 7 in., 20 lb beam with a 10 ft span support a concentrated load of 4,000 lbs?

Solution: The dotted lines drawn across the chart show how this problem is solved. Draw a straight line from 10 ft (Column A) through 20 lb (Column B) and locate the intersection on Column C. From this intersection (Column C), extend the line to the 7 in. marker of Column E. The intersection of this line with Column D indicates that this I-beam will support a concentrated load of 7,000 lb. Thus the beam is amply strong so far as the 4,000 lb load is concerned. In fact, it is indicated by the chart that a 4 in. I-beam, all other conditions being equal, will safely support this load of 4,000 lb.

Similarly, it is easy to ascertain the maximum allowable span when the factors in Columns B, D and E are known. Or you can find the necessary weight per foot of an I-beam when the factors in Columns A, D and E are known. And lastly, the depth of beam is determinable when the factors in Columns A, B and D are known.

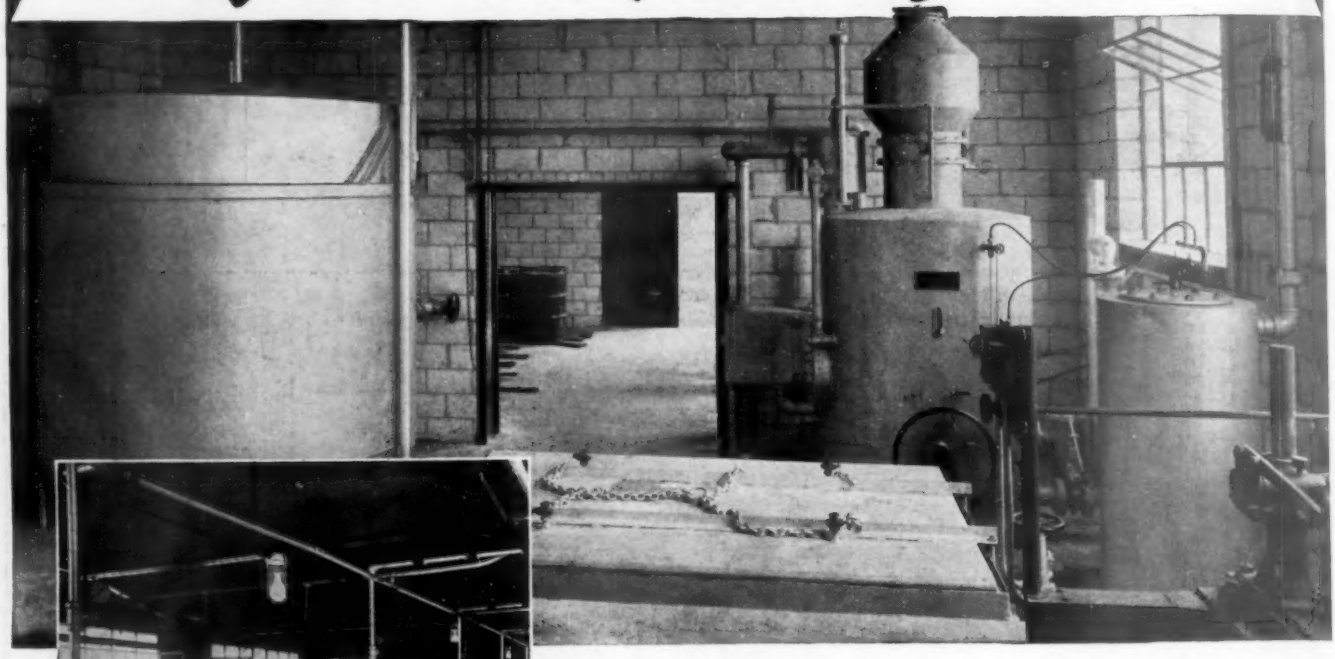
For loads that are "uniformly distributed"—not concentrated—the safe loads in Column D may be multiplied by two. Thus, the above described beam will support a uniformly distributed load of 14,000 lb or 1,400 lb per ft.



Independent Engineering Co.

PRODUCERS OF MODERN

Acetylene Compressing Plants



A Typical Acetylene Compressing Plant laid out and constructed by the same long experienced engineers available through *Independent* facilities for design and construction. Backed by over 50 years of accumulated operating experience.

INDEPENDENT Acetylene Compressing Plant Installations represent the accumulated operating experience of more than 50 years . . . in the design and construction of this type of equipment.

When the opportunity arises to erect a plant of this type—take advantage of this long experience—bring your problems to us—we have the "know how" that will give you maximum operating efficiency plus maximum operating *safety*.

Independent Engineering Co.

101 WEST SECOND STREET, O'FALLON, ILLINOIS

Pipe Lines Completed, Ease East's Oil Needs

Pipe lines completed last month should go far toward relieving the eastern oil shortage. They include the 551 mile, 24 in. line from Longview, Tex., to Norris City, Ill., and the 108 mile, 8 in. emergency gasoline pipe line between a point near Akron and Tiffin, O.

The Akron-Tiffin pipe line was designed to expedite the flow of gasoline from Tiffin, Toledo, Lima, Chicago and other mid-western refinery centers to the Atlantic ocean. Construction was begun last October.

The Longview-Norris City pipe line was completed on January 21. In the speeding of this mammoth transportation project, workmen at times reached the daily average of about 6 miles of pipe and on one occasion set a record of laying 9.93 miles in one day.

The line, which will cost 35 million dollars, will have a capacity of 1,600,000 bbl. It will deliver 300,000 bbl of crude oil daily to rail tank cars for transhipment to the East, making possible a net increase of 120,000 bbl daily to the East Coast and thus partly easing a difficult transportation problem.

Work on the second link of this line, an 857 mile pipe line extending from Norris City to the New York-Philadelphia refining area, is under way. It is expected to be completed about June and will add 60 million dollars to the cost of this project.

Engineers have estimated that when this 24 in. pipe line has been completed from Longview to the East Coast it will hold 4,000,000 barrels of oil—as much as all of the wells in the United States produce in one day. The line, moreover, will be capable of transporting as much oil as could be carried by 85 tankers.

» «

Steel Warehouse Men Form Permanent Scrap Committee

A new "duration" scrap program has been inaugurated to extend the work begun during the American Steel Warehouse Association's drive of the last three months of 1942. The formation of a permanent National Dormant Scrap Committee of the Steel Warehouse Industry assures WPB of the continued help of 1,500 to 2,000 well qualified steel warehouse salesmen to augment local WPB field staffs. Plans have been formulated to make calls on over 70,000 industrial firms which are potential sources of dormant scrap.

The Dormant Scrap Committee is headed by J. J. Hill, Jr., president-treasurer, Hill Chase & Co., Philadelphia. Other committee members are: Harry Edgcomb, Edgcomb Steel Corp., Hillside, N. J.; L. B. Worthington, Scully Steel Products Co., Chicago; Harry K. Hamilton, Hamilton Steel Corp., Cleveland; Sol Friedman, Reliance Steel Corp., Cleveland; and Walter S. Doxsey, Cleveland, ex-officio member.

John R. Hartman has been named executive chairman, while thirteen prominent steel warehouse men have been chosen to serve as regional chairmen. National headquarters are at 2617 Fidelity-Philadelphia Bldg., Philadelphia.

» «

To Publicize War Part of Parts Manufacturers

The American Brake Shoe and Foundry Co. will use its 1943 advertising appropriation to spotlight the important rôle which manufacturers of parts are playing in America's war program.

The plan was outlined by President W. B. Given, Jr., in announcing the appointment of Brooke, Smith, French & Dorrance, Inc., of New York and Detroit, as the company's advertising agency. "We are witnessing in this country," said Mr. Given, "the most marvelous job of industrial coördination in the world's history, and a great deal of credit for its success is due to the performance of plants that produce millions of parts for thousands of manufacturers."

» «

Southern Safety Conference

A two-day working conference of southern safety leaders will be held March 1 and 2 at the Hotel Peabody, Memphis.

On any surface . . . on any job
SKILSAW
SANDER-GRINDER
gives you
FINER FINISHING FASTER!
SKILSAW Model "SL" SANDER-GRINDER. Speeds metal cleaning with a wire brush, quickly removes rust and scale—prepares for finishes.
SKILSAW DISC SANDER. Smooths down welding beads with sanding disc. Flexible pad conforms to concave or convex surfaces . . . speeds up all work.
Whatever your surfacing jobs may be, it's a safe bet that SKILSAW Model "SL" SANDER-GRINDER will do them easier, better, faster! It quickly prepares surfaces for welding, grinds welds down swiftly . . . cleans rust, scale and grit from metals and castings . . . files, sands, buffs and polishes with a wide variety of accessories. And everywhere Model "SL" greatly increases output per man per minute because it's lighter, easier to handle—more powerful, faster-working!
Model "SL" is typical of all the SKILSAW PORTABLE GRINDERS, BELT SANDERS, DISC SANDERS that you'll find on the job in America's busiest war plants. Your distributor will gladly demonstrate them on your own work.
SKILSAW, INC., 4763 Winnemac Ave., Chicago
New York • Boston • Buffalo • Philadelphia • Cleveland • Detroit
Indianapolis • St. Louis • Kansas City • Atlanta • New Orleans
Dallas • Los Angeles • Oakland • Portland • Seattle • Toronto, Can.
SKILSAW PORTABLE ELECTRIC TOOLS
★ MAKE AMERICA'S HANDS MORE PRODUCTIVE ★

Shrink Galvanizing without Zinc Fumes

Albina Engine and Machine Works & Shipyard, Portland, Ore., has perfected a method of flame-shrinking galvanized plates without burning and without toxic zinc fumes. The new method, it is claimed, eliminates the fumes entirely.

Essence of the Albina plan is to use a highly oxidizing flame—about 15 lb of oxygen to 10 lb of acetylene. The torch is lighted with a neutral flame—oxygen 1.05, acetylene 1.00—which is then starved at the torch by turning down the acetylene valve while the orignal pressure is maintained in the hose. This starving is said to cool the flame.

The 11-hole torch tip (10 holes in a circle of ⅛ in. radius surrounding a center hole) is held from ¾ to one in. from the galvanized surface; the flame is held steady until the metal becomes cherry red. At this point the temperature is estimated at about 600 F, which is well below the 750 F melting point of galvanizing. When a barely perceptible flowing is noted on the surface of the heated spot, the flame is withdrawn. The heated spots are made about an inch apart, and water from a water-quenching ring must be kept flowing at all times.

The withdrawal of the flame at the right moment requires experience, but it is said that practice under the eyes of a man proficient in the method will turn a learner into an expert within two hours.

Under the old system, shrinkers on galvanized tanks, etc., or in close quarters, used two men to a torch, each man working but 15 minutes at a time. Despite this precaution, each shrinker lost an average of six days a month from fume sickness. Moreover, the turnover in shrinking crews was large because few men liked this type of work. The new method enables flame-shrinkers to put in their full eight hour shifts.

Albina has established a shrinking school to teach the new process, this school being open without charge to employees from all war industries. Most pupils, it is stated, graduate within two hours.

» «

Mass Production Methods on Ship Turbines and Gears

The war has now made it possible to put ship steam turbines and reduction gears on a mass production basis. According to word from the Westinghouse engineering department, a new plant has been built to manufacture just two sizes of turbines and gears—4,000 and 8,500 hp. Old established production line methods have been combined with many new schemes particularly adapted for turbine and gear manufacture.

In this new plant, arc welding is being used to a far greater extent than is usual for these products. To expedite the production of consistently high quality welds, a special turntable was devised for holding the parts. Use of this welding manipulator permits the operator to swing the work in front of him and do downhand welding at all times.

The subassembly idea has been used to advantage in making gear housings. Instead of adding heavy plates to foundation piece till finished, the housings are now built in eight separate assemblies, which are welded together to form the whole. The subassembly method permits the welding to be done on easily handled sizes, while the use of the positioning turntable makes it possible to do only downhand welding.

In order to avoid building many new large lathes and vertical boring mills, cemented carbide tools have been substituted for standard high-speed steel cutting tools. The cutting speed has been raised from about 50 to approximately 220 ft. per min.

» «

Need Becomes More Urgent for Government Engineers

Educational and experience requirements have been lowered to meet the increased demand for Government engineers, it was announced last month by the Civil Service Commission. For the grades of Assistant Engineer, $2,600 a year, through Chief Engineer, $8,000 a year, professional engineering experience will be accepted in lieu of the requirement for a full 4-year course leading to a bachelor's degree in engineering.

In addition to the educational qualification, one year of professional engineering experience or graduate study is required for Assistant Engineer. For higher positions, applicants must show additional experience of a progressively higher level. Graduate study will be accepted on the same basis as engineering experience up to the $3,200 a year level.

There are no age limits for applicants, and no written tests will be given.

What hard-facing stands heat best?

Coast Metals Hard-Faced bit at left. Unfaced bit at right.

THIS TONG BIT TEST WILL TELL YOU AT ONLY A FEW PENNIES' COST...

JUST APPLY to one of your stripper or soaking pit tong bits the recommended Coast Metals Hard-Facing. Then do the same to the other bit. But here use some other brand of hard-facing metal. Or, if you prefer, leave this second bit uncoated.

Result: You'll find Coast Metals *wins in lengthening tong bit life* at high temperatures. In one case, Coast Metals hard-faced bits pulled 75 heats of 22 ingots, each weighing 4,000 pounds,—a total of 6,600,000 pounds all together. Ordinary bits wore out after two or three heats! In another case, Coast Metals Hard-Facing increased the life of slabbing mill tong bits SIX TIMES!

COAST METALS

hard-facing weld rods

What is *your* wear-resistance problem? Write us and see how Coast Metals Hard-Facing can help you protect your equipment against wear, abrasion, impact, shock! And keep your production running smoothly, without unnecessary time out for repairs or replacements! Get facts today.

COAST METALS, INC.
Plant and General Offices: Canton, Ohio
Executive Offices: New York, N.Y.

YOUR EQUIPMENT'S LIFE PRESERVER AGAINST WEAR

A New Pipe Line under Consideration

Donald M. Nelson, chairman of the War Production Board, announced on January 21 that a decision would shortly be made to determine whether or not WPB will allocate materials for the construction of a new pipe line from Texas to Seymour, Ind., a town in the south central part of the state.

This line would be a 20 in. welded pipe line to carry refined petroleum products. It would parallel for much of its route the recently completed crude oil line from East Texas to Norris City, Ill.

ABOUT PEOPLE

Those in our nation's armed forces may continue to read THE WELDING ENGINEER at a special reduced price of $1.50 per year for the duration.

» «

A reorganization has been effected in the Welding and Electroplating Equipment Branch of WPB. **O. L. Howland** remains as chief of the branch, but W. M. Haile has been advanced to deputy chief. He was formerly chief of the Gas Welding and Cutting Section.

J. C. Cumberland becomes chief of the Arc Welding Section, and **J. H. Cooper** chief of the Resistance Welding Section, succeeding J. D. Tebben. The new chief of the Gas Welding and Cutting Section has not yet been named.

R. L. Hawkins takes the post of chief of the Arc Welding Machine Unit and **P. M. Hall** that of chief of the Resistance Welding Unit. **H. R. Smith** remains chief priority specialist.

» «

Colonel John C. Minor has been granted a leave of absence by the Taylor-Wharton Iron and Steel Co. in order that he may accept a position as consultant on gas cylinders with the War Production Board in Washington. Colonel Minor has been manager of cylinder sales for Taylor-Wharton during the past 14 years.

» «

Raymond M. Dennis has been appointed assistant to the president of By-Products Steel Corp., Coatesville, Pa. He will have charge of the staff and general administrative work for the corporation, which is a subsidiary of Lukens Steel Co. Previously, Mr. Dennis was general manager of the flanging department of Lukens, in charge of estimating, sales and production of flanging.

» «

V. Gilmore Iden has resigned as secretary of the American Institute of Steel Construction in order to accept the position of industrial editor of the Bureau of National Affairs, 2201 M St., N.W., Washington, D. C. David Lawrence, editor of the United States News, is president of the Bureau of National Affairs.

» «

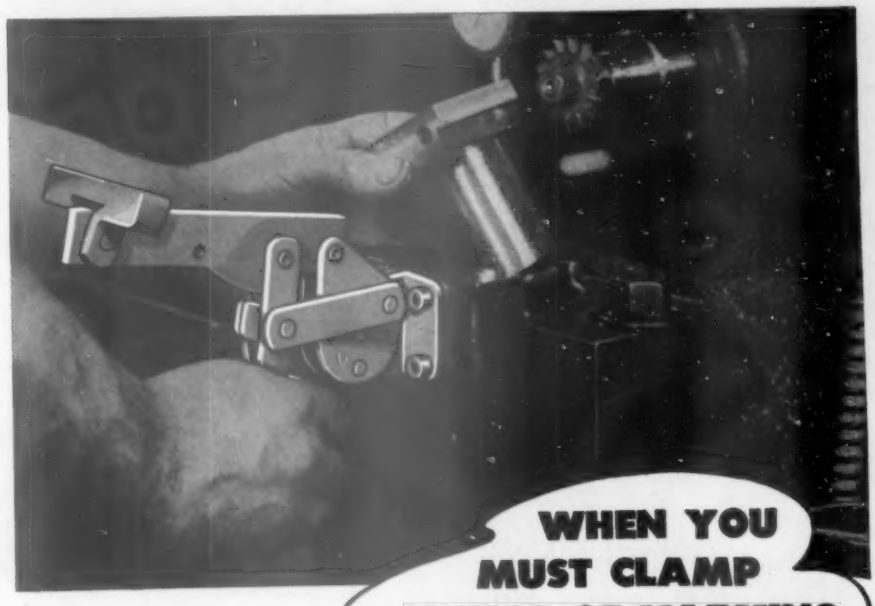
J. Wesley Cable, research and development engineer of Induction Heating Corp., 389 Lafayette St., New York City, has assumed the added responsibilities of general sales manager. He has been with the Induction Heating Corp. since 1941.

» «

Walter Moehlenpah has been appointed field welding engineer, Progressive Welder Co., for the territory comprising Missouri, southern Illinois, western Indiana, southeast Kansas, southeast Nebraska and southwest Iowa. Mr. Moehlenpah, recently in charge of marketing of the "Frostrode" refrigerating units for resistance welders, has been with Progressive Welder for two years.

» «

John S. Morris has been appointed methods engineer for By-Products Steel Corp., Coatesville, Pa. He was formerly assistant consulting engineer of the new "facilities program" at Lukens Steel Co. In his new position, Mr. Morris will carry on special developmental work in connection with improved methods.



WHEN YOU MUST CLAMP THINGS OF VARYING THICKNESSES

...use this KNU-VISE clamp of versatility

Because this KNU-VISE Clamp permits a wide range of clamping applications while base remains fixed in the same position—because it will hold parts or assemblies that may vary in thickness as much as 15°—and because it can be pivoted around the base to any angle or height within 90°—this model is gaining great acceptance in industry. It is raising the efficiency of clamping and eliminates tedious and slow hand adjustments.

Send for new catalog

KNU-VISE INCORPORATED

1338 Plum Street, Detroit, Mich.
4328 San Fernando Rd., Glendale, Calif.

E. L. Foote, who for some time has been selling welding equipment in the Chicago area, organized his own welding supply company the first of this year. The new concern is known as the Eureka Welding Supply Co. and is located at 9233 Commercial Ave., Chicago. It will handle Harris Calorific Products, Eureka tool and die electrodes and Alloy Rods stainless steel electrodes.

» «

W. G. Paton and **W. R. Engstrom** have been elected vice-presidents of The Austin Co., engineers and builders of Cleveland. Mr. Paton will also assume the posts of assistant secretary and assistant treasurer. He was formerly assistant to the general manager. Mr. Engstrom has been district manager of the company's Seattle territory since 1933.

» «

Leo Edelson has joined the Induction Heating Corp., 389 Lafayette St., New York City, as executive vice-president. He has been development engineer for Handy & Harman during the past ten years.

» «

W. A. Cramer, formerly assistant traffic manager, has been appointed traffic manager, western district, of the United States Steel Corp. subsidiaries. He succeeds **M. N. Billings,** who is retiring after 39 years of service.

Helpful Literature Just Published

The following reviews are of recent publication of interest to those in the welding industry. Unless otherwise stated, they may be obtained without cost by writing to the manufacturer or to THE WELDING ENGINEER.

Tube-Turn Data Book

Tube Turns, Inc., Louisville, has just published a 239-page looseleaf book entitled, **"Tube-Turn Catalog and Engineering Data Book No. 111."** This data book, which is completely indexed, is also fitted with thumb tab index so that the various sections may be easily located.

The book is divided into 4 sections dealing with engineering, welding fittings, flanges and technical data. The engineering section presents facts about the practical engineering advantages and piping problems solved by employing welding fittings and piping systems. The engineering principles involved in the design of Tube-Turn products are discussed in this section.

Section 2, Welding Fittings, is a catalog section presenting essential data on every welding fitting in the Tube-Turn line. This includes information regarding type of fitting, weight, part number, dimensions and price. Photographic and diagrammatic illustrations of each fitting greatly simplify the use of this section of the catalog.

Every type of flange in the Tube-Turn line is described under Section 3, Flanges. There is also given all dimension and price information. Important technical data and new engineering information pertinent to flanges and their use are also included in this section.

Section 4, dealing with technical matter, includes many exclusive studies which have been presented for the first time. Worthwhile technical information pertaining to welding fittings and welded pipe systems will be found in this section. It is also accompanied by many new charts and reference tables.

In all, Tube-Turn data book No. 111 is

Do All This With Miller Industrial Welders!

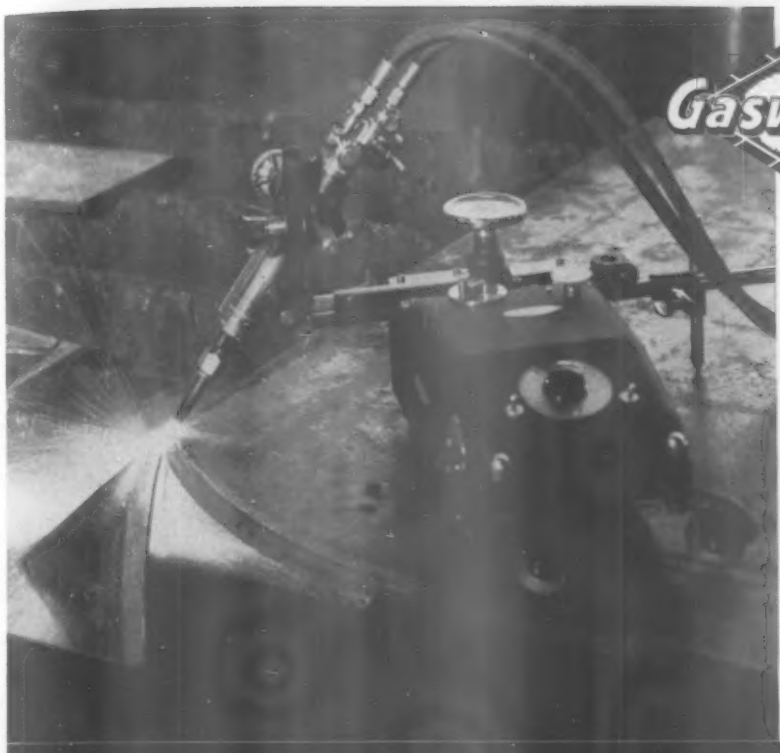
- SPEED UP PRODUCTION
- CUT LABOR COSTS
- GET STRONGER WELDS
- ELIMINATE MAINTENANCE COSTS

- SAVE IN ELECTRODE COSTS
- SAVE POWER COSTS
- HAVE LOWER INSTALLATION COSTS
- HAVE TWO OPEN CIRCUIT VOLTAGES

Write Today for Complete Story on These Benefits

MILLER ELECTRIC MANUFACTURING CO.

Factory: Appleton, Wisconsin
Sales: Richmond, Indiana



Gasweld

G-W PORTABLE FLAME CUTTING MACHINE

● The "Gasweld" G-W Flame Cutting Machine is a portable, motor driven torch for cutting billets and straight lines, strips, circles, arcs or simple irregular outlines in steel plates. Either straight or beveled edge cuts are easily made.

Cuts can be made clean and accurate, eliminating in many cases, the need for further machining. Light, compact—weighing only 45 pounds—the machine is easily moved from place to place in the shop. Speed range—four to sixty inches per minute; travels either forward or in reverse direction.

The G-W Portable Flame Cutting Machine effectively lowers cutting costs and speeds production over hand-cutting methods.

Write for illustrated bulletin and price to

Buffalo, N. Y.
Cincinnati, O.
Chicago, Ill.
Detroit, Mich.
Louisville, Ky.
Milwaukee, Wis.

WALL CHEMICALS DIVISION of
The Liquid Carbonic Corporation
3110 S. Kedzie Ave., Chicago, Ill.

Rochester, N. Y.
Toledo, Ohio
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Montreal, Quebec
Toronto, Ontario
Windsor, Ontario

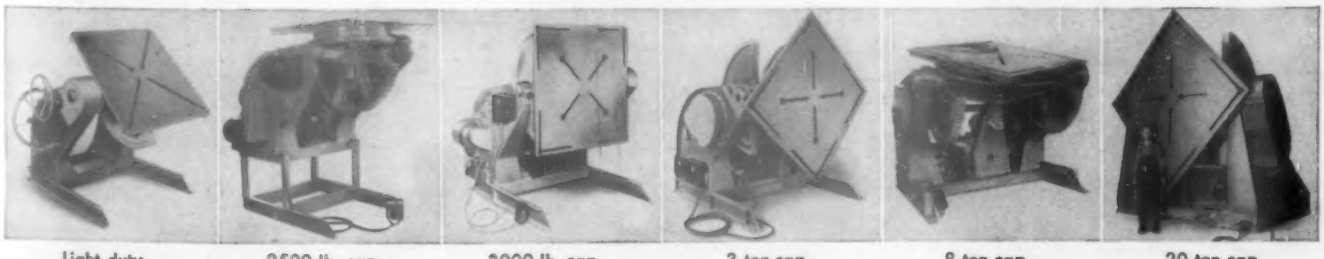
We'll hold it while you weld it...

If you're doing a welding job on war production, you can get Ransome Positioners to help you increase your output and reduce costs.

With this modern equipment, your welders can readily swing the heaviest and most complicated pieces for a downhand position on every pass . . . top, sides, and bottom, with one set-up.

Made in a complete range of types and sizes . . . hand-operated and motor-operated . . . up to 20-ton capacity . . . there's a unit that will fit your needs exactly.

● ***Write for literature showing how Ransome Positioners can solve some of your major welding problems.***



Light-duty, hand-operated | 2500-lb. cap., elevating base | 3000-lb. cap. | 3-ton cap. | 8-ton cap. | 20-ton cap.

Ransome WELDING POSITIONERS

INDUSTRIAL DIVISION • RANSOME MACHINERY COMPANY • DUNELLEN, NEW JERSEY

a complete compilation of essential technical information on pipe welding, welding fittings and flanges. It incorporates many useful studies never before available, together with helpful new arrangements and indexing of complete, exact data for greater convenience of buyers and specifiers of welding fittings.

» «

Symbol Hammer Circular

A 4-page circular issued by the **Atlas Welding Accessories Co.**, 307 Boulevard Bldg., Detroit, gives complete information on a system for identifying the welds of individual weldors by means of a combination chipping hammer and symbol marker. Data are included on various methods of identification for crews ranging from 5 to 15,000 weldors.

» «

Women Weldors' Catalog

Bearing a 4-color process cover of an attractive young lady weldor, a 12-page, 8 by 10 in. catalog, "Arc Welding Accessories for Women," **GEA-3295,** has been issued to present the G-E line of safety clothing and equipment for the country's steadily increasing army of girl welding operators. Among the items illustrated and described are tailored leather welding jackets, sleeves, aprons, gloves, flameproof duck aprons and sleevelets and a special flameproof hat, designed by Sally Victor, which can be worn under the welding helmet. **General Electric Co.**, Schenectady, N. Y.

» «

Data on Cable Care

A 4-page, 8½ by 11 in. circular giving six rules for the care of welding cable has been published by the **Welding Engineering Co.**, Milwaukee. An included table lists cable sizes from 6 to 4/0, and gives the amperes, strands, OD, ID and weight in lb per M ft for each cable size.

» «

A-C Welding Booklet

An 8-page, 8½ by 11 in., two-color catalog, **Unit X4576,** gives the latest information available on the Emerson line of A-C arc welders. The line includes six models, which range in capacity up to 300 amp. **The Emerson Electric Mfg. Co.**, 1824 Washington Ave., St. Louis.

» «

Safety Clothing Catalog

Catalog No. 45, "Safety Clothing and Equipment for Industry," covers some 107 products, most of which are necessary equipment in the welding field. This is a 68-page book, 8½ by 11 in., bound with plastic rings and profusely illustrated. **Safety Clothing and Equipment Co.**, 7016 Euclid Ave., Cleveland.

» «

Gas Pressure Data

The general equations which determine the effect of pressure on the specific heats of eight gases over wide ranges of pressures and temperatures are given in **Bulletin No. 30,** a 28-page, letterhead-size publication of the Cornell University Engineering Experiment Station. The gases are air, carbon dioxide, carbon monoxide, ethylene, hydrogen, methane, nitrogen and oxygen; the temperature range is from 0 to 4,000 F, and the pressure range is from 0 to 10,000 psi.

Single copies of this bulletin may be secured without charge by writing to the **Engineering Experiment Station**, Cornell University, Ithaca, N. Y.

» «

Safety Newspaper

American Optical Co., Southbridge, Mass., announces a new publication, **The Safety Clipper,** for use by editors of employee newspapers or magazines in promoting industrial safety. It is hoped that such editors will reprint the articles appearing in this miniature newspaper and thus help persuade workers to use the goggles, protective clothing and safety devices supplied to them. Any article or illustration that appears in the **Safety Clipper** may be reprinted without asking for permission, and electrotypes or photographs of the illustrations and cartoons used will be supplied free of charge.

Gremlins detest

MARQUETTE
REG. U.S. PAT. OFF.
A.C. ARC WELDERS

Welding has its Gremlins too, and altho, obviously nobody has ever seen a live Gremlin, operators know plenty about their love for causing trouble on busy production lines.

Gremlins, however, aren't on speaking terms with MARQUETTE engineers. These men, with their years of experience and leadership in the A.C. welding field, have found ways to stymie all of the favorite Gremlin tricks.

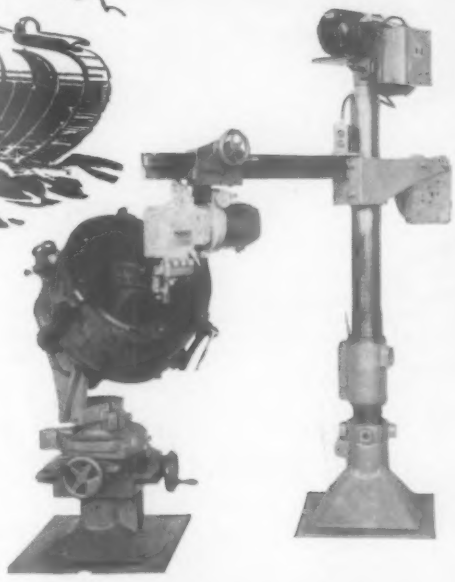
They've built these versatile machines in models up to 400 amperes, delivering superb arc performance for fast, flawless welding without snuff-outs or the slightest trace of "magnetic blow." Just the right heat can be selected instantaneously, and every heat stage has automatic voltage control for perfect welding current. No confusing dials or gadgets, no guess-work. The Gremlins haven't a chance for their vexations that slow up work and make inferior welds.

Send for free, 24 page, illustrated booklet.

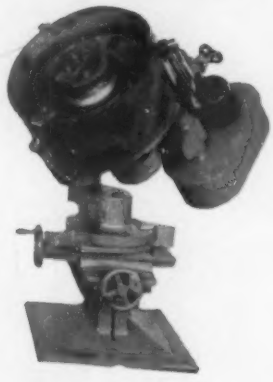
MARQUETTE MFG. CO., INC.
Minneapolis Minnesota

MARQUETTE
REG. U.S. PAT. OFF.
A.C. ARC WELDERS

Quicker Welding . . . With This Automatic Welding Machine Fixture



Reloading Is done During Welding Operation



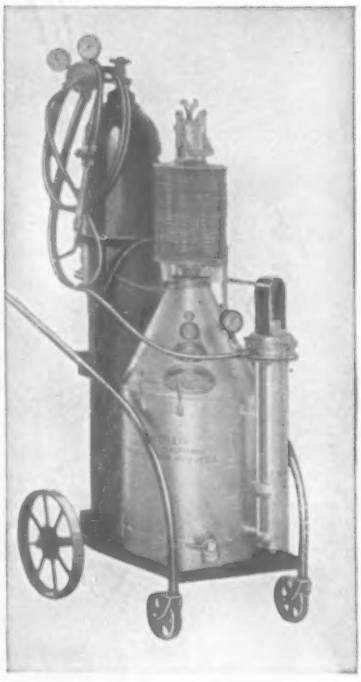
THIS Acme dual fixture arrangement permits practically constant use of an automatic welding head, because one of the fixtures can be reloaded while the other is engaged in the welding operation.

The holding machine can be set to revolve at any angle from vertical to horizontal. (Illustration shows a wheel being welded at 45° angle.) Positioner arm swings from one fixture to the other, locking in proper position. Speed of rotating the work is adjustable, as desired.

ACME Manufacturing Co.
1642 HOWARD ST. • DETROIT, MICH.

WRITE
for information. Whatever your positioning problem on automatic welding, let us help you solve it. Write for complete information.

Here Is a New Way!



The War Production Board has indicated that there is a real need to conserve acetylene cylinders.

Undoubtedly you are doing everything possible to assist in the war effort. Well, here is a new way in which you can help out — a way which you may not have considered previously.

Release acetylene cylinders for the military forces and elsewhere in the war effort by turning to SIGHT FEED Acetylene Generators for your acetylene.

And Kill Two Birds With One Stone!

In addition to conserving acetylene cylinders, you will slash your acetylene costs 50% to 75%. The savings will help pay next year's taxes.

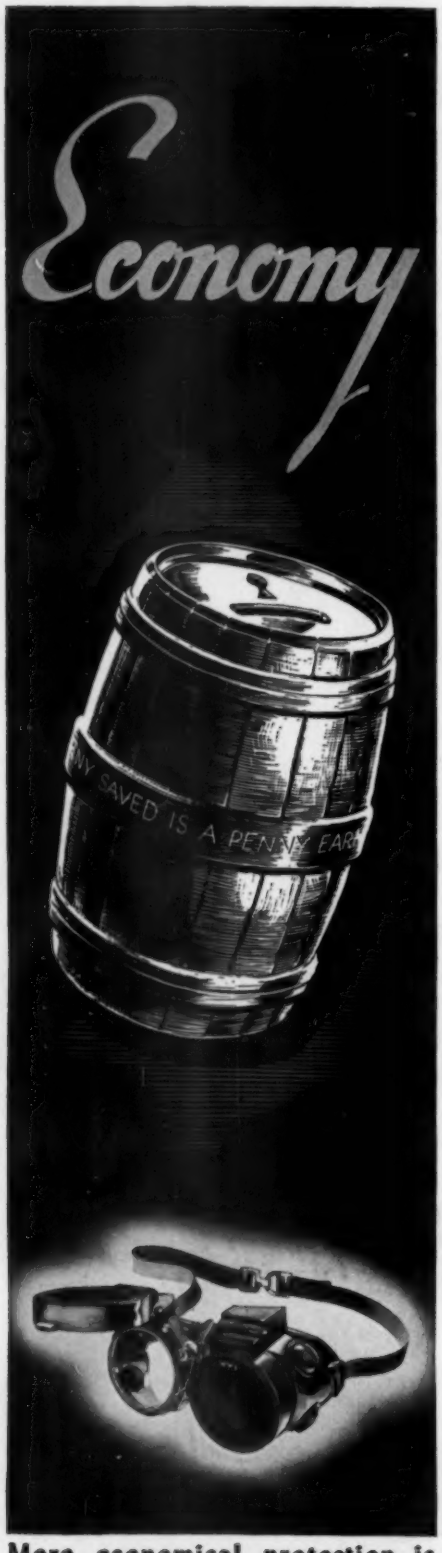
Furthermore, by having a SIGHT FEED Acetylene Generator on hand, you are assured of having acetylene on hand when and as you need it.

Make your selection from five portable models and five stationary models. SIGHT FEED offers you a size for every purpose.

Be patriotic! And help yourself! Write today for details.

The Sight Feed Generator Company

Richmond • Indiana



More economical protection is obtained from Willson Industrial Goggles and Respirators in rough shop use, because of skilful design and careful selection of materials.

There is a Willson Goggle, Respirator, Gas Mask or Helmet for every industrial hazard. See your local Willson Representative or write direct.

GOGGLES • RESPIRATORS • GAS MASKS • HELMETS

WILLSON

PRODUCTS INCORPORATED
READING, PA. U.S.A. Established 1870

Metal Cleaning Manual

A 40-page manual, published primarily to provide aircraft company executives with the latest data on production degreasing and maintenance cleaning techniques, may be obtained by writing to **Oakite Products, Inc.,** 57 Thames St., New York City. Among the operations discussed are the preparation of aluminum alloy parts for spot welding and the degreasing of ferrous and non-ferrous metals for heat-treating, Magnaflux testing, pickling, etc.

» «

Esco Clothing Catalog

Eastern Safety Clothing Co., 23 West 60th St., New York City, has just issued catalog **No. 711-A** covering the complete Esco line of weldors' protective clothing for men and women. This new catalog describes and illustrates full coats, overalls, capes with bib attached, capes with detachable bibs, pants, aprons of plain and slit types, sleeves, rod holders, shoe protectors, etc.

» «

Brazer Circular

This 4-page, 8½ by 11 in. circular describes a line of equipment for brazing and soldering with silver solder. The equipment includes an electric brazer having plier jaws in which the object to be heated may be held and brought up to silver soldering temperature. Lap, butt, scarf, cable or spud joints may be made by this method. **Ideal Commutator Dresser Co.,** 1284 Park Ave., Sycamore, Ill.

» «

Tool Poster

A patriotic red-white-and-blue poster illustrating four ways in which to get longer life from cemented carbide tools will be sent free on requests addressed to **Vascoloy-Ramet Corp.,** North Chicago, Ill. This poster was designed in accordance with a WPB request for visual educational material for war workers. It measures 48 by 27 in. and bears no advertising except the company's logotype.

Eye Shield Catalog

To mark its 40th year in business, the **Chicago Eye Shield Co.,** 2300 Warren Blvd., Chicago, has just issued its 25th catalog of equipment for the prevention of eye injuries. This two-color, 50-page, 8½ by 11 in. booklet illustrates and describes over 50 classifications of safety products, including spectacles, goggles, lenses, masks, helmets, shields and respirators.

» «

Training Handbook

"Training Employees as Job Instructors," is the title of a new handbook issued by the Policyholders Service Bureau of the **Metropolitan Life Insurance Co.,** One Madison Ave., New York City. Among subjects discussed are the selection of job instructors, the time and place for their training, consequences of inadequate training, training costs, etc. Samples of training programs now in operation in war production industries and exhibits of the material used in such programs are also included.

» «

Electronics Booklet

A non-technical account of the "science of the electron" is given in a colorful pictorial booklet, "Electronics—A New Science for a New World." The story is told of how the electron is today working in war combat, in research, in radio and television-equipment and finally in war industry, where it acts to step up production, increase human efficiency and reduce material waste. A copy of this booklet, **GED—1024,** may be obtained from the **General Electric Co.,** Schenectady, N. Y.

» «

Strain Gauge Bulletins

Baldwin Southwark Div. of The Baldwin Locomotive Works, Philadelphia, has just issued three new technical bulletins. One of these describes use of the company's SR-4 strain gauge in an entirely new method for determining stresses in structures and machines. The other two bulletins give detailed information on the recording and indicating instruments used with SR-4 strain gauges.

Any shape he draws

A UNISHEAR can follow!

...and cut it FASTER than any other tool!

Wherever sheet metal departments are "beating the promise", you'll find Stanley Unishears on the job. They slice through sheets as fast as you feed, up to 15 feet per minute – follow any line accurately, straight, curved or angle – leave smooth, clean edges with no distortion. Plenty of power and ruggedness for tough production or maintenance use.

Portable models with capacities up to 12 U. S. gauge hot rolled steel. Stationary models to handle sheet metal up to 10 gauge. Stanley Electric Tool Division, The Stanley Works, 177 Elm Street, New Britain, Connecticut.

1843 STANLEY 1943
TRADE MARK

TOOLS ARE THE WORKER'S WEAPONS IN A TOTAL WAR. KEEP THEM ON THE JOB WITH PROPER CARE . . . .

STANLEY UNISHEARS

The Electrically Driven Hand Shears

AMPCO-TRODE

THE *Only* COATED ALUMINUM BRONZE WELDING ROD

Electrodes of AMPCO METAL Have Excellent Bearing Properties

For overlaying bearings, shafts, and sliding surfaces, you can select a grade of Ampco-Trode coated bronze electrodes with the assurance that its bearing characteristics are excellent. Ampco-Trode is made of Ampco Metal, an alloy of the aluminum bronze class, long recognized among America's leading industrial engineers as outstanding as a bearing metal. It has toughness and wear-resistance to a remarkable degree.

Ampco-Trode electrodes are suitable for overlaying steel and cast iron, building up shafts, wear strips, forming and drawing dies; refacing for extreme wear-resistance.

With Ampco-Trode you get smoother arc action. Beads adhere better; slag is easily removed.

Ampco-Trode is made in six grades and six sizes—⅛" to ½". It is suitable for metallic arc, carbon arc and oxy-acetylene welding.

Get the facts about this remarkable coated bronze electrode. Write for free bulletin describing Ampco-Trode.

AMPCO METAL, INC.

Dept. WR-2 Milwaukee, Wisconsin

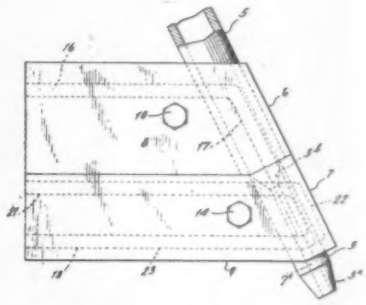
FROM THE PATENT OFFICE

Resistance Welding Control

2,305,591. **Arthur B. Sonneborn**, Detroit, Mich., assigned to **The Clark Controller Co.**, Cleveland. Filed Oct. 26, 1938. Issued Dec. 22, 1942.

This patent pertains to a resistance welding apparatus having an electrical circuit and a contactor element operating under fluid pressure. The contactor is a fluid pressure movable element which closes and, after a predetermined time interval, opens the energizing circuit. A timer and means associated therewith control communication of fluid pressure to the contactor in order to maintain it operated for a predetermined time interval after opening of the circuit; the timer is actuated by a means responsive to movement of the contactor element.

» «



Automatic Welding Guide

2,306,050. **George J. Frischmann**, Queens Village, N. Y., assigned to **Metropolitan Engineering Co.**, Brooklyn. Filed April 19, 1940. Issued Dec. 22, 1942.

Referring to an automatic, metallic arc welding head through which coated electrode wire is fed continuously, this patent covers an electrode guide tube supported by the welding head, a metallic nozzle arranged to receive and guide the electrode to the work, and a combined water jacket and clamp for securing the nozzle to the guide tube. The two separate pieces for clamping guide tube and nozzle have passages for circulating a liquid cooling medium.

» «

Resistance Welding Control

2,306,428. **Francis G. da Roza**, Ferndale, Mich., assigned to General Motors Corp., Detroit. Filed May 21, 1941. Issued Dec. 29, 1942.

This patent refers to a resistance welding control apparatus having a plurality of electric discharge devices of the immersed ignition electrode type connected in inverse relation between the source and load. It covers the circuit interconnecting the ignition electrodes and the source and a synchronous switching means connected into the circuit for controlling the periods of energization of the ignition electrodes.

SAVE TIME
for Your War Effort
—Speed Production With . . .

SPATTER-NOX—Reduces weld spatter 50-75%; cuts cleaning time 50%; increases welding speed 30-50%. Inhibits rust and is a good foundation for paint. Simply brush or spray on. Covers 650-700 sq. ft. per gallon. Low priced—$1.75 per gallon.

SPATTER-OFF — A companion water soluble product. Used where welds are to be pickled for galvanizing, sherardizing or plating. Spatter-Off is non-fuming. Covers 500 sq. ft. per gallon. Low priced—$1.00 per gallon.

Write for latest descriptive bulletin or trial sample

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4299 Euclid Avenue Cleveland, Ohio

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CLAMPS

Extra quality—A large variety to choose from

STEEL BAR CLAMPS
CARRIAGE CLAMPS
SPECIAL WELDERS
C CLAMPS
HANDSCREWS

Send for Catalog No. 16

ADJUSTABLE CLAMP CO.
"The Clamp Folks"
426 N. Ashland Ave., Chicago, U.S.A.

Why play blindman's buff?

"Some people waste a whole evening trying to find a 'nice,' 'cheap' place to stay. Not me! I pick out a good hotel and my worries are over. Everything I need is right at my elbow."

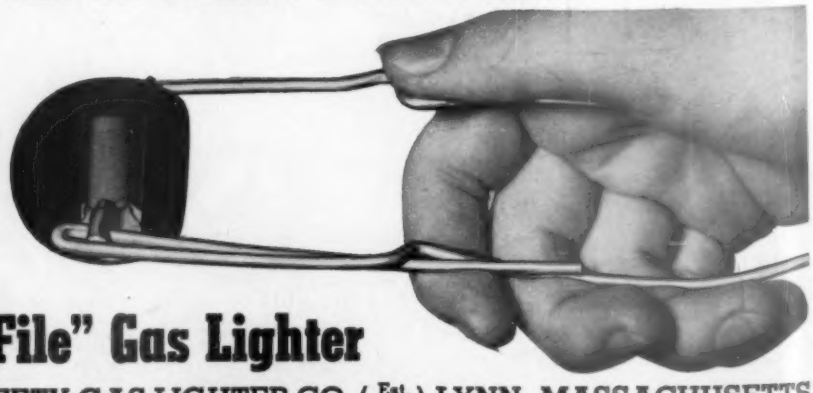
J. D. Findlay, Raleigh, N. C.

AMERICAN HOTEL ASSOCIATION
FOR A FRESH START
STOP AT A **HOTEL**

Locking "Slip-on" Renewal

The patented cartridge holding the spark metal locks exactly in correct position, permitting instant replacement. Get acquainted with the many other superior, exclusive features of Improved "Round File."

an exclusive feature



The Improved "Round File" Gas Lighter

Circulars and prices on request. SAFETY GAS LIGHTER CO. (Est. 1901) LYNN, MASSACHUSETTS

Protective Garments

Pay Handsome Dividends in Safety, Health and Increased Production. Every Welder Needs Good Protection.

Singer Protective Leather Clothing

SINGER garments are all made of special "Chrome Tan" leather—heavy, soft and pliable. Perfection down to smallest details.

COMPLETE SAFETY PROTECTION
"From Head to Toe"

Overalls, Pants, Coats, Aprons, Bibs, Chaps, Sleeves, Capes, Spats, Short Jackets

Practical Designs Approved by Weldors

Singer Safety Clothing incorporates all the protective features, all the conveniences, developed with the help of weldors on all types of welding jobs. It has met the test for safety and comfort.

PROMPT DELIVERY

Inquiries invited from jobbers. Write for catalog and price list.

SINGER LEATHER CLOTHING CO.
Sole Manufacturers of Singer Protective Clothing —the Standard Line Since 1930
129-135 North 12th Street Philadelphia, Pa.

DON'T SCRAP IT
WELD IT
YOUR PART IN THE WAR PROGRAM—
CONSERVE
LABOR AND MATERIAL
USE
FUSE-WELL RODS
FOR YOUR CAST IRON

The Chicago Hardware Foundry Co.
Dependable Since 1897
1242 Engineering Building
NORTH CHICAGO, ILLINOIS

TWECO "HOLGRIP" ELECTRODE HOLDERS

Fully Insulated

"Hol-Grip" Sr.

TWECO "Hol-Grip" Holders are now made in the 150 ampere Jr. size, 300 ampere Sr. Size, No. 500 (500 ampere) size, and Super Model (600 ampere ½" and ⅝" electrode capacity). Write for new TWECO General Bulletin No. 1943-G.

DELIVERY?—YES!!

Delivery is still prompt on all TWECO PRODUCTS.

Why? The answer is we manufacture *only* Cable Connections for Electric Welding and are tooled to deliver the goods.

See your local distributor or write us for more information on:

TWECO GROUND CLAMPS
ELECTRODE HOLDERS
CABLE CONNECTORS
CABLE LUGS

TWECO PRODUCTS

TWECO PRODUCTS CO.
English at Ida Wichita, Kansas

WRITE FOR **FREE INFORMATION**

If you operate any equipment on which some surfaces are subject to extra wear, you can save time and money by hard surfacing such areas. Scores of satisfied users have reported great success with Bergstrom Hard Surfacing Electrodes. Give maximum wear resistance. Easily applied in any position. AC or DC, with freedom from porosity. Six types—each designed to do a specific job. Write for full information.

BERGSTROM *Free Flowing*
HARD SURFACING ELECTRODES

UNITED STATES STEEL SUPPLY CO.
formerly Scully Steel Products Company
CHICAGO · NEWARK, N. J. · PITTSBURGH
CLEVELAND · ST. LOUIS · BOSTON
BALTIMORE · ST. PAUL-MINNEAPOLIS

UNITED STATES STEEL

UNITED STATES STEEL SUPPLY COMPANY — USS STEELS — SERVICE

Castolin Eutectic
LOW TEMPERATURE WELDING

Large two cylinder air compressor with badly cracked water jacket. Salvaged with Castolin Eutectic Low Temperature Welding Alloy. No general preheating. Time: 1½ hours.

IMPROVED RECLAMATION OF CAST-IRON CASTINGS

WHY waste time and materials? Reclaim broken, cracked, worn or defective castings, easily, economically. Use Castolin Eutectic Alloy No. 14 (gas welding) and Castolin Eutectic Alloy No. 24B (AC-DC metallic arc). These new low temperature welding alloys assure you of a completely machinable, color matching, stress and distortion free weld every time.

Prominent manufacturers now use Castolin Eutectic Low Temperature Welding Alloys No. 14 and No. 24B in place of "hard to get" bronze welding rods. Castolin Eutectic Alloys No. 14 and No. 24B contain no scarce metals . . . available with priority A9.

WRITE FOR DATA BOOK K8

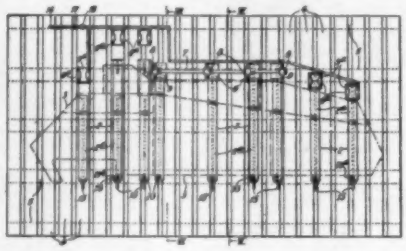
Castolin Eutectic Low Temperature Welding Alloys are the *original low temperature alloys* that are revolutionizing *production welding, maintenance welding* and *salvaging* in war plants throughout the nation. There are 38 specialized rods for every metal and every welding job. Made only by Eutectic Welding Alloys Company.

Tool Salvaging Poster for Your Shop Free!

EUTECTIC
WELDING ALLOYS CO.
40 Worth St. · New York, N. Y.

Welding Jig

2,304,493. **William Edmund Bullock,** near Compton, Wolverhampton, England, assigned to **Guy Motors Ltd.,** Wolverhampton, England. Filed January 27, 1941. Issued Dec. 8, 1942.



On the rigid base of this jig are mounted plate-supporting members, which are adapted to support plates in the planes in which they are to be butt welded together and have their upper surfaces recessed to receive backing metal strips. Pivoted arms associated with the plate-supporting members carry clamping devices to exert a resilient pressure on the plates; these arms may be locked against the reaction of the clamping devices.

» «

Coated Electrode

2,303,746. **Theodore Ephraim Kihlgren,** West New Brighton, Staten Island, N. Y., and **Raymond Francis Vines,** Plainfield, N. J., assigned to **The International Nickel Co., Inc.,** New York City. Filed Nov. 29, 1941. Issued Dec. 1, 1942.

This patent pertains to an arc welding electrode having a specified coating and to the method for forming this coating. The dry ingredients—about 50 to 90 parts calcium fluoride, about 50 to 10 parts sodium fluoride, at least 10 parts titanium and carbon—are mixed together to form a substantially homogeneous dry powder. A solution of dextrine and water is prepared by heating for at least 15 min at a temperature of about 155 to 185 F. The dextrine solution is then combined with the dry powdered ingredients to form a plastic mass, which is extruded around the welding electrode and dried to produce a coating having satisfactory adhesion and uniform burn-off.

» «

Projection Welding Method

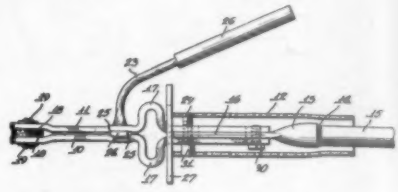
2,303,933. **Douglas A. S. Hale,** Ramsey, N. J., assigned to **Bell Telephone Laboratories, Inc.,** New York City. Filed Feb. 5, 1942. Issued Dec. 1, 1942.

A method of joining a thin laminated piece of metal of comparatively high melting point to metal of a comparatively low melting point. The method consists in forcing an opening with upturned edges in the thin laminated piece, pressing the upturned edges against the other piece, and passing welding current through the connection thus formed until molten metal of the low melting point wells up through the opening in sufficient quantity to form an interlocking key.

» «

Electrode Holder

2,305,189. **Frank J. Nowicke,** Hanover, Md. Filed July 14, 1942. Issued Dec. 15, 1942.

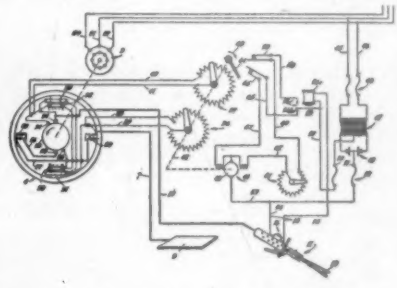


An electrode holder comprising a pair of jaws, a guard and a connector within the guard. The connector is a tubular member housing one end of an electrical conduit; it has a flat portion which is secured to the rearwardly extending flat portions of the jaws by a pair of bolts. One bolt passes through the guard to lock it to the connector.

» «

Crater Eliminator

2,305,206. **Karl Strobel,** Whittier, Calif., assigned to **Stroco Products, Inc.,** Los Angeles. Filed April 30, 1940. Issued Dec. 15, 1942.



A method of preventing the formation of a crater at the conclusion of an electric arc welding operation. The method comprises the maintaining of a substantially constant arc length and arc voltage while gradually and uniformly reducing the arc current from a normal value until melting of the electrode has substantially stopped and the arc breaks of its own accord.

» «

Multiple Spot Welder

2,304,121. **Hugo Purat,** Detroit, assigned to **Progressive Welder Co.,** Detroit. Filed Dec. 13, 1940. Issued Dec. 8, 1942.

This patent refers to the combination of a movable electrode, the means for moving it into engagement with the work, and the means for supporting and for completing an electrical circuit to the electrode. The latter comprises a member having a conductive surface complemental in form to and releasably engageable with the electrode conductive surface.

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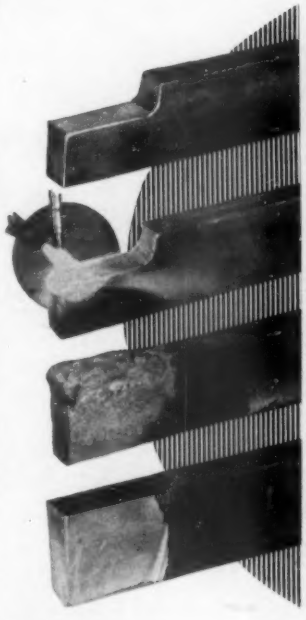

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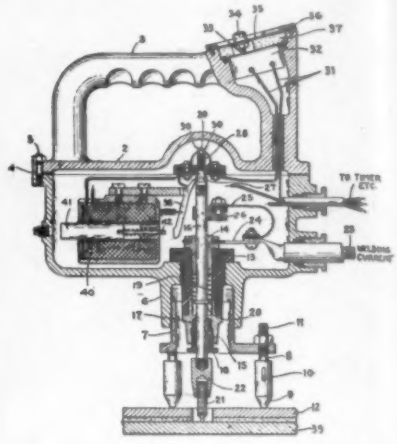
Subaqueous Stud Gun

2,307,026. **John D. Crecca,** United States Navy. Filed Oct. 25, 1940. Issued Jan. 5, 1943.

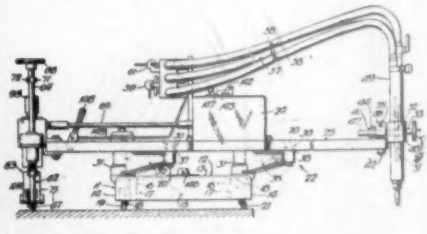


An arc welding stud gun for underwater welding. A spring-impelled plunger, suitably insulated and surrounded by a watertight gland, is slidably mounted within a watertight hollow body. One end of the plunger extends beyond the walls of the body, while the other end terminates in a latching head that is engageable with a spring biased latch. The latch is disengaged by the movable core of a solenoid, the core being movable only when solenoid is energized. When latch is engaged with head, a pair of contacts are conductively connected by a circuit closing conductive member insulatingly carried by the other end of the plunger. The control circuit also includes a watertight switch for closing the circuit and a means governed by the control circuit to supply welding current to a stud in an electrode holder affixed to the extending end of the plunger. Longitudinally yieldable legs rest against the work piece to which stud is to be welded.

» «

Flame-Cutting Machine

2,305,909. **Fred Stoneberg,** Chicago, assigned to **Gaso Equipment Co.** Filed May 31, 1941. Issued Dec. 22, 1942.



Pertaining to a flame-cutting apparatus, this patent covers the carriage, a torch-supporting bar and universally adjusted cutting head, the means for mounting the head on one end of the bar, a tracer wheel on the opposite end for guiding the movements of bar and carriage, and a tractor operated by a motor and change speed mechanism which are mounted on the central portion of the bar and movable therewith.

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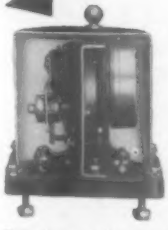

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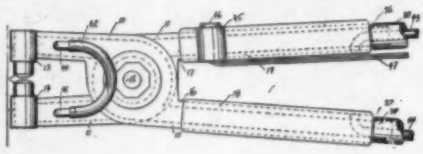
Spot Welding Gun

2,304,975. **Ralph Warrender,** Sharon, Pa. Filed Sept. 6, 1941. Issued Dec. 15, 1942.



A brazing or welding gun in the form of a pair of tongs comprising a pair of conducting members, each of which includes an insulated handle and a jaw for retaining a removable electrode. The conducting members are pivotally affixed to each other and insulated from one another. In each member, channels are provided to receive a cooling agent, which is allowed to circulate throughout both members by means of an interconnection for this purpose. The two handles are connected with a suitable current source.

» «

Impact Welding

2,305,042. **Ralph S. Thacker,** West Los Angeles, Calif., assigned to **Leo M. Harvey,** La Canada, Calif. Filed May 28, 1940. Issued Dec. 15, 1942.

This patent covers the process of resistance welding which comprises (1) increasing the pressure between two metallic elements in a continuous manner from a low value to a high value and (2) passing a welding current between the elements for an interval beginning substantially above the low pressure and ending substantially below the high pressure. The initial pressure forces the elements being welded into contact; the holding pressure (after application of the current) allows the fused metal to congeal. A forging blow may also be used to supplement the continuous pressure.

» «

Electrode Holder

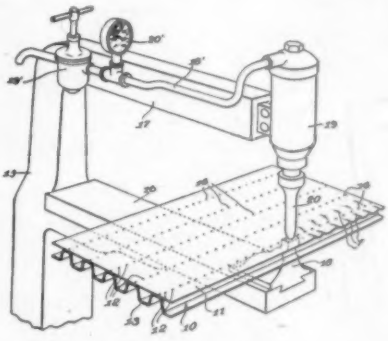
2,304,321. **Henry J. Wagner,** Jackson, Mo. Filed Nov. 8, 1941. Issued Dec. 8, 1942.

An electrode holder comprising a tubular handle of insulating material which contains an elongated metallic housing. At one end of the housing a conductor cable is connected, and at the other end is a shank having a longitudinal channel. A stationary jaw coöperates with a pivoted jaw on the shank, while a bar, slidable in the channel, is hingedly connected to the pivoted jaw. An insulating sleeve is secured to both bar and shank, and a coil spring in the housing actuates the bar in a direction to close the pivoted jaw. The jaw may be opened manually against tension of spring.

» «

Sheet Metal Peener

2,304,976. **Michael Watter,** Philadelphia, assigned to **Edward G. Budd Mfg. Co.,** Philadelphia. Filed Sept. 7, 1939. Issued Dec. 15, 1942.



A method of postweld treating a thin gauge sheet of metal in which sheet distortions have been produced in the unwelded metal as a result of stresses created incident to the heating and cooling of a row of spot welds. The distortion-producing stresses are removed by permanently expanding the row of welds in the plane of the sheet. This is done by peening the sheet along the row of welds, the successive peenings being in substantially overlapping relation. Through this action the distorted unwelded metal is substantially restored to its initial undistorted condition.

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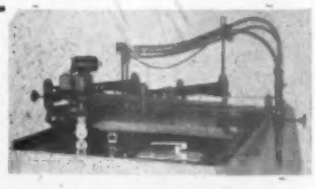

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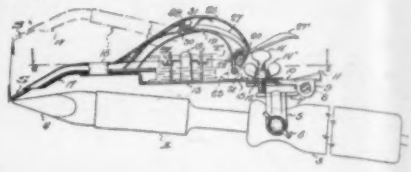
Soldering Iron Feed

2,303,947. **Sidney A. Moore,** Milwaukee. Filed Aug. 26, 1940. Issued Dec. 1, 1942.



A solder wire feeding device for a soldering iron. Elements are a support carried by the soldering iron, a plate with rear end rockably mounted on the support, and a guide for directing solder wire to the tip of the iron. The guide is carried by the forward end of the plate; a spool holder is arranged intermediate the ends of the plate, and a spool of solder wire is carried by the holder. A manually-actuated means feeds the solder wire from the spool through the guide, and a thumbpiece is provided for rocking the plate in order to lift the guide away from the iron.

» «

Resistance Welding Apparatus

2,304,021. **Charles H. Rippl,** Cleveland, assigned to **The Clark Controller Co.,** Cleveland. Filed Feb. 7, 1936. Issued Dec. 1, 1942.

This patent pertains to a resistance welder having movable electrodes. Elements are: a fluid pressure supply line; means for introducing fluid under pressure; means responsive to the fluid pressure to move the electrodes into engagement with the work; air pressure supply and distributing lines normally out of communication with each other; a switch communicating with the air distributing line and able to control the circuit to the electrodes; a valve, controlling communication between the air lines and movable to open position by the fluid pressure flowing through the fluid supply line, which is able to close the circuit. In timed relation to the closing of the circuit, a means responsive to the fluid pressure supplied from the air distributing line opens the switch. An adjustable means is provided for regulating the switch-opening means in order to control the time interval.

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